RUBBER RESEARCH INSTITUTE

OF

MALAYA.

ANNUAL REPORT, 1929.

IMPERIAL BUREAU
7 JULY 1930
OF MYCOLOGY

Published by
The Rubber Research Institute of Malaya
and Printed by
Kyle, Palmer & Co., Ltd., Kuala Lumpur, F.M.S.

Price $1/-.

THE RUBBER RESEARCH INSTITUTE OF MALAYA INC.

MEMBERS OF THE BOARD.

1930

The Director of Agriculture, Straits Settlements and Federated Malay States:—

Dr. H. A. TEMPANY, D.SC., F.I.C. President and Chairman, 1930.

Member nominated by the High Commissioner to represent the interests of Small-holders:—

CHE' HAMZAH BIN ABDULLAH.

Member nominated by the High Commissioner to represent the States of Johore, Kedah, Perlis, Kelantan and Trengganu:—

The Secretary to the High Commissioner for the Malay States (J. D. HALL, Esq.)

Members appointed by the Rubber Growers' Association:—

Hon. Mr. J. S. ARTER, M.F.C.
C. B. GRABURN, Esq.

Members appointed by the Planters' Association of Malaya:—

Hon. Mr. H. B. EGMONT-HAKE, M.F.C.
E. N. T. CUMMINS, Esq. (on leave).
R. S. CHANTLER, Esq. (Acting).

Member appointed by the Asiatic Planters' Association of Malaya:—

K. ARUMUGAM, Esq.

Financial Officer nominated by the High Commissioner:—

The Treasurer, Federated Malay States.
(Hon. Mr. G. P. BRADNEY, M.F.C.).

Finance Committee.

Dr. H. A. TEMPANY, Chairman.

Hon. Mr. H. B. EGMONT-HAKE. C. B. GRABURN, Esq.
Hon. Mr. G. P. BRADNEY. Hon. Mr. J. S. ARTER.

Executive Committee.

Dr. H. A. TEMPANY, Chairman.

Hon. Mr. G. P. BRADNEY. Hon. Mr. J. S. ARTER.
Hon. Mr. H. B. EGMONT-HAKE. C. B. GRABURN, Esq.

Experiment Station Committee.

Dr. H. A. TEMPANY, Chairman.

Hon. Mr. G. P. BRADNEY. K. ARUMUGAM, Esq.
Hon. Mr. H. B. EGMONT-HAKE. Hon. Mr. J. S. ARTER.
C. B. GRABURN, Esq.,

Provident Fund Trustees.

Hon. Mr. G. P. BRADNEY, Chairman. Hon. Mr. J. S. ARTER.
Hon Mr. H. B. EGMONT-HAKE. Major B. J. EATON.

Research Committee.

Dr. H. A. TEMPANY.
Planting Members of the Board.
Co-opted Members.
The Director.
The Heads of Divisions.

LONDON ADVISORY COMMITTEE.

P. J. BURGESS, Esq., M.A., F.C.S. (Chairman).
Dr. E. J. BUTLER, C.I.E., F.R.S.
W. DUNCAN, Esq.
Sir JOHN FARMER, M.A., D.SC., LL.D., F.R.S.
Lt. Gen. Sir WILLIAM FURSE, K.C.B., D.S.O.
Sir W. GEORGE MAXWELL, K.B.E., C.M.G.
B. D. PORRITT, Esq., M.SC., F.I.C., F.R.S.E., F.I.R.I.
Sir JOHN RUSSELL, D.SC., F.R.S.
Dr. D. F. TWISS, F.I.C., F.I.R.I.

ANNUAL REPORT OF THE BOARD.

FOR THE YEAR ENDED 31st DECEMBER, 1929.

The Rubber Research Institute of Malaya came into existence on the 1st September 1925, by virtue of the Incorporating Enactment No. 8 of 1925. The present year, therefore, constitutes the fourth in the Institute's existence but as the active operations of the Institute can only be said to date from the appointment of a Director in September 1926, the present constitutes the third completed year of active operation.

2. The government of the Institute is provided for by a Board consisting of 10 members. At the commencement of the year the composition of the Board was as follows:—

(a) F. W. South, Esq., Ag. Secretary for Agriculture, President and Chairman, (ex officio).

(b) Member nominated by the High Commissioner to represent the interest of small-holders.
Che' Hamzah bin Abdullah.

(c) Member nominated by the High Commissioner to represent Unfederated Malay States. The Secretary to the High Commissioner for the Malay States.
J. V. Cowgill, Esq.

(d) Members nominated by the Rubber Growers' Association.
Hon. Mr. J. S. Arter and C. Ritchie, Esq.

(e) Members appointed by the Planters' Association of Malaya.
The Hon. Mr. H. B. Egmont Hake, absent on leave. C. B. Graburn, Esq., acting, and the Hon. Mr. E. N. T. Cummins.

(f) Member appointed by the Rubber Producers' Association of Malaya.
J. M. Sime, Esq.

(g) Member appointed by the Asiatic Planters' Association of Malaya.
Loh Kim Swi, Esq.

(h) Financial Adviser nominated by the High Commissioner. Treasurer to the Federated Malay States, the Hon. Mr. H. G. R. Leonard.

3. By Ordinance No. 5 of 1929, the provision whereby the Secretary for Agriculture was ex officio Chairman of the Board was cancelled and the Board was permitted to elect any member to the Office of President and Chairman; at the same time the post of

Secretary for Agriculture having been abolished and that of Director of Agriculture substituted, the Director of Agriculture became ex officio member of the Board.

(a) In consequence of this Mr. F. W. South relinquished his seat on the Board of the Institute in April 1929 and Dr. H. A. Tempany, the newly appointed Director of Agriculture took his place. At the Meeting held on April 27th, 1929, Dr. Tempany, Director of Agriculture, was unanimously elected President and Chairman of the Board for the balance of the ensuing year.

(b) Che' Hamzah bin Abdullah representing Malay small-holders was on leave from 9th of November, 1928, until the 22nd June, 1929. No substitute was appointed during his absence.

(c) Mr. J. V. Cowgill, Acting Secretary to the High Commissioner sat as representative for the Unfederated Malay States until the 4th of May, 1929, from which date he was replaced by Mr. J. D. Hall.

(d) The Hon. Mr. J. S. Arter went on leave on the 21st of February and resumed his seat on the 16th of December. During Mr. Arter's absence on leave Mr. J. W. Kennedy was appointed to act for Mr. Arter as representative of the Rubber Growers' Association.

(e) The Hon. Mr. H. B. Egmont Hake was on leave until the 3rd of April; Mr. C. B. Graburn acted as substitute for Mr. Hake during the latter's absence.

(f) Mr. C. Ritchie resigned his seat on the Board on his retirement from Malaya, and Mr. C. B. Graburn was appointed to replace him as one of the representatives of the Rubber Growers' Association with effect from August 7th.

(h) Mr. Loh Kim Swi resigned his seat as representative of the Asiatic Planters' Association of Malaya on the 25th of March and Mr. K. Arumugam was appointed in his place as from the 11th of May.

4. On December 31st the composition of the Board was therefore as follows:—

(a) President and Chairman—Dr. H. A. Tempany, Director of Agriculture, S.S. & F.M.S.

(b) Member nominated by the High Commissioner to represent the interests of small-holders.
Che' Hamzah bin Abdullah.

(c) Member nominated by the High Commissioner to represent the States of Johore, Kedah, Perlis, Kelantan and Trengganu.
J. D. Hall, Esq.

(d) Members appointed by the Rubber Growers' Association.
The Hon. Mr. J. S. Arter and C. B. Graburn, Esq.

(e) Members appointed by the Planters' Association of Malaya.

The Hon. Mr. H. B. Egmont Hake and the Hon. Mr. E. N. T. Cummins.

(f) Member appointed by the Rubber Producers' Association of Malaya.
J. M. Sime, Esq.

(g) Member appointed by the Asiatic Planters' Association of Malaya.
K. Arumugam, Esq.

(h) Financial Adviser nominated by the High Commissioner. The Treasurer, Federated Malay States (The Hon. Mr. H. G. R. Leonard).

5. Attendance at Meetings.

During the year 44 Meetings of the Board and its Committees were held which are shown as below:—

Board Ordinary	...	7
Board Special	...	5
Executive Committee	...	12
Finance Committee	...	13
Experiment Station	...	7
		44

The followng table shows the attendances of members compared with the possible number of Meetings which each could have attended:—

	Board Ord.		Board Special.		Executive Com.		Finance Com.		Expt. Stat. Com.		Total.	
	Act. Attnd.	Pos. Attnd.	Act. Attnd.	Pos. Attnd.	Act. Attnd.	Pos. Attnd.	Act. Attnd.	Pos. Attnd.	Act. Attnd.	Pos. Attnd.	Act. Attnd.	Pos. Attnd.
1. F. W. South Esq. -	1	3	5	5	2	2	2	2	...	...	10	12
2. Dr. H. A. Tempany -	6	6	...	...	7	7	8	8	4	4	25	25
3. Che' Hamzah bin Abdullah -	4	4	...	...	...	...	...	...	...	...	4	4
4. J. V. Cowgill Esq. -	2	2	2	5	...	...	...	...	...	...	4	7
5. J. D. Hall Esq. -	2	5	...	...	...	...	...	...	..	...	2	5
6. Hon. Mr. J. S. Arter -	1	1	2	2	3	3	3	3	1	1	10	10
7. C. Ritchie Esq. -	5	5	4	5	7	7	7	7	4	4	27	28
8. C. B. Graburn Esq. -	2	3	4	5	3	3	4	4	2	2	15	17
9. J. W. Kennedy Esq. -	2	5	...	...	...	...	...	...	1	3	3	8
10. Hon. Mr. H. B. Egmont Hake -	6	6	...	...	8	9	9	10	4	5	27	30
11. Hon. Mr. E. N. T. Cummins -	7	7	5	5	11	12	12	13	7	7	42	44
12. J. M. Sime Esq. -	2	7	1	5	...	...	...	...	...	...	3	12
13. K. Arumugam Esq. -	2	5	...	...	...	...	...	...	...	...	2	5
14. Hon. Mr. H. G. R. Leonard -	7	7	5	5	12	12	12	13	7	7	43	44
	49	66	28	37	53	55	57	60	30	33	217	251

NOTE.—Board Meetings Nos. 23 and 24 held on the 27th April are taken as one Meeting.
Board Meeting No. 25 held on the 21st June and adjourned to 25th June is taken as two Meetings.

6. Accounts.

The accounts for the year ending 31st December, 1929, as passed by the Auditors of the Institute, are printed as an Appendix to this Report.

7. Income.

The following statement shows the contributions that have been received from the various Contributing Administrations during each year of the Institute's existence up to the 31st December, 1929:—

	F.M.S.	S. S.	Johore.	Kedah..	Kelantan.	Trengganu.	Total for year.
Income prior to Incorporation i.e. to 1st Sep. '25.	130,664	32,805	37,500	15,750		1,648	218,367
1925. (1st Sept. to 31st Dec.)	81,020	14,580	16,668	7,000		608	119,876
1926	269,145	60,705	50,000	21,000	7,837	2,881	411,568
1927	214,371	48,540	50,000	21,000	9,837	3,002	346,750
1928	293,079	65,942	50,000	21,000	9,603	2,820	442,444
1929	437,495	95,000	50,000	21,000	13,733	3,714	620,942
Total Income to 31st Dec. 1929.	$1,425,774	317,572	254,168	106,750	41,010	14,673	2,159,947
Percentages.	66.01	14.70	11.77	4.94	1.90	0.68	100

For general information the following statement is published concerning the basis of the contribution of each of the various Administrations:—

Paragraph 5 of the Report of the Institute (unpublished) for the year 1925 reads as follows:—

> "The revenue of the Institute will be provided for by a cess of 10 cents a pikul on all rubber exported from the territories of the contributing administrations, subject to various conditions stipulated by certain of the administrations."

The Governments acquiescing in the scheme are those of

(i) The Straits Settlements.
(ii) The Federated Malay States.
(iii) Johore.
(iv) Kedah.
(v) Kelantan.
(vi) Trengganu.

and the "various conditions" referred to in the preceding paragraph are set forth below.

Straits Settlements. The contribution of this Government is subject to the three following conditions:—

(i) For such period as the Federated Malay States contribution is based on 10 cents per pikul on all rubber produced and exported, the amount calculated on that basis in respect of the Straits Settlements shall be the contribution of that Government.

(ii) If at any time during the period of the contribution by the Straits Settlements Government the contribution by the Federated Malay States falls short of what would be obtained by a cess of 10 cents per picul in the Federated Malay States, the Colony contribution will be decreased in proportion as the former is less than the latter.

(iii) If, at any time, the total annual revenue of the Institute exceeds the requirements of annually recurrent expenditure (including interest and sinking fund charges on any loans to the Institute which have been mutually agreed upon by the Governments concerned) the Colonial Government reserves the right to reconsider the amount of its annual contribution.

Johore. This Government has agreed to make an annual contribution on the following terms:—

(i) The contribution is not to exceed—

(a) 10 cents a pikul on rubber exported from Johore.

or

(b) $50,000.

or

(c) An amount proportionate to the contribution of the F.M.S.

(ii) The contribution is guaranteed for 10 years. After payment of the tenth contribution, the Johore Government may at any time give two years' notice of cessation.

Kedah. This Government has agreed to join in the scheme for a period of 5 years in the first instance, and its contribution is subject to a maximum annual payment of $21,000/-.

The remaining contributing administrations i.e., the Federated Malay States, Kelantan and Trengganu pay to the Institute the equivalent of 10 cents a pikul on all rubber exported from their respective territories

In relation to the imposition of the export cess, up to the end of 1929, the only Government which has imposed and collected the cess is that of Trengganu. The Government of the Federated Malay States and the other Governments have up to December 31st made

payments out of the revenue equivalent to the calculated yield of the cess, but have not actually imposed it. As from January 1st, 1930, the Federated Malay States Government has arranged to impose the special duty of 10 cents per picul in accordance with the approved arrangements, the other administrations have not so far done so. Owing to the irregular incidence of the contributions to the revenue of the Institute the Board agreed at the end of 1929 that the Government of the Federated Malay States should be approached with a view to endeavouring to arrange a conference of all contributing administrations with the object of endeavouring to secure a uniform basis of contribution throughout. In October, 1929, the question was raised by the Straits Settlements Government of the operation of Clause 3 of the special condition which is attached to the contribution of this administration, and in consequence a deputation of the Board waited on and interviewed the Colonial Secretary in Singapore for the purpose of discussing the question.

8. Capital and Recurrent Expenditure.

The following table shows the Capital and Recurrent Expenditure in each year up to the end of 1929:—

		Capital Expenditure.	Recurrent. Expenditure
		$	$
1925,	...	28,565	3,431
1926,	...	172,673	54,934
1927,	...	381,330	276,712
1928.			
	$		
Institute,	159,820		
Experiment Station,	47,752	207,152	396,341
1929.			
Institute,	23,734		
Experiment Station,	293,968	317,702	426,426

For the first time in 1929 a proportion of the expenditure incurred in the development of the Experiment Station at Sungei Buloh has been included in Recurrent Expenditure. The basis of apportioning this expenditure is only tentatively laid down at present. The question will receive further consideration during the coming year.

9. Special Enquiry.

During the year the special enquiry which had been sitting in the latter part of 1928 to enquire into (a) the internal affairs of the Institute and (b) the so-called Ashplant controversy, continued and concluded its sittings. Two communiques setting out the result of the enquiry were issued to the press on the 9th February and the 21st June.

10. Provident Fund.

The Statement of Accounts and the Report for the year 1929 disclosed that the position of the fund has shown much improvement during the year, this improvement arising chiefly from two causes (a) the increased volume of the fund owing to the accumulation of contributions in the ordinary way with the passing of time has enabled the Trustees to invest moneys more remuneratively, and (b) the retirement of senior members of the staff prior to completing three years' membership of the fund has substantially increased the reserve.

It is anticipated that from this date onwards members' accounts will receive satisfactory increases by way of distribution of profits each half year.

11. New Permanent Laboratory.

The lease of the premises occupied by the Institute will expire in 1935. The buildings at present occupied by the Institute are considered inadequate as a permanent home for its activities, and in consequence some discussion took place during the year in relation to the policy to be adopted with a view to making more permanent provision in this respect. The question is still under consideration, and it is anticipated that a decision may be reached in this respect during 1930.

12. London Advisory Committee.

Correspondence was maintained with the London Advisory Committee which held 5 meetings during the year. The questions of research programmes of the Institute and of liaison between the Institute and other bodies engaged in research on rubber in Ceylon and in the United Kingdom were discussed with the Advisory Committee by correspondence; the London Advisory Committee also assisted in the selection and recruitment of certain new members of the staff.

13. Junior Staff.

The conditions and terms of service of the Junior Staff were considered by the Executive Committee during the year and certain recommendations were submitted to the Board which were subsequently adopted. These comprise inter alia the time scale classification of salaries for all grades of junior employees together with provision for leave, transport allowance etc.

H. A. Tempany,

President and Chairman, 1929.

March, 1930.

ANNUAL REPORT 1929.

BY

THE ACTING DIRECTOR.

Introduction.

Considerable progress has been made in the work of the Institute in several directions during the past year, in spite of important changes in the personnel and shortage of staff.

Staff.

Dr. G. Bryce, Director, left the Institute on the 27th July from which date the writer was appointed by the Board to act as Director.

Botanical Division

Mr. F. Summers' services as Head of the Botanical Division were terminated on the 3rd October, from which date the work of the Division has been divided between Mr. L. E. Morris (Geneticist) and Mr. C. E. T. Mann (Plant Physiologist), under the general supervision of the Acting Director.

Pathological Division

Dr. J. R. Weir, Head of the Pathological Division, resigned his appointment on the 15th July, in order to take up the appointment of Director of the Research Laboratories of the Goodyear Rubber Plantations, Sumatra. Mr. A. R. Sanderson was appointed to act as Head of the Pathological Division, pending the appointment of a new Head

Mr. H. Sutcliffe (Pathologist) proceeded on long leave on the 10th January and returned to duty on the 10th October.

Chemical Division

Mr. R. O. Bishop was appointed Chemist in the Chemical Division and assumed duties on the 1st October. From this date he was also appointed to act as Head of the Division in place of Major B. J. Eaton.

Mr. R. G. Fullerton acted as Head of the Chemical Division from July 27th to October 1st.

Dr. E. Rhodes, Biochemist, was transferred to the Chemical Division on the 1st August, 1929.

Mr. K. C. Sekar was confirmed in his appointment as Assistant Chemist with effect from the 1st July.

Soils Division

Mr. K. S. Pillai was appointed on probation as Assistant Soils Chemist on the 1st February.

Field Division

The appointment of a Chief Field Officer was approved by the Board. Mr. G. Davidson was recommended by the London Advisory Committee and approved by the Board but had not assumed duty at the end of the year. This appointment will serve to co-ordinate the work of the Field Division and in due course to relieve the Research Divisions of much advisory work.

Mr. N. C. Jenkins (Field Officer) was transferred to Johore and stationed at Johore Bahru on January 10th, in order to investigate conditions on small-holdings in that State and to advise generally.

Library

Mr. P. S. Hudson resigned his post as Librarian on the 31st July, in order to take up another appointment in England.

Experiment Station

Mr. D. S. Gardner, Manager of the Experiment Station, resigned on the 7th May, in order to take up another appointment. His services were retained as Visiting Agent and Mr. H. W. Foston was appointed Manager from the same date.

Co-operation and Liaison with Other Organisations.

Considerable advances have been made in the matter of securing co-operation and liaison with other cognate institutions in Malaya, particularly with the Department of Agriculture, S.S. & F.M.S., and with the Co-operative Societies Department, S.S. & F.M.S. This effort has been concerned particularly with work on behalf of owners of small rubber holdings from which class the Institute derives a considerable proportion of its revenue.

Liaison with Department of Agriculture, S.S. & F.M.S

A Conference of Field Officers of the Department of Agriculture, S.S. & F.M.S., arranged and presided over by the Director of Agriculture, S. S. & F. M. S., Dr. H. A. Tempany, was held in October.

The Acting Director and the Field Officers of the Institute were invited to attend the second session of this Conference for the purpose of discussing co-operation between the Department and the Institute in connection with advisory work on small-holdings in particular.

Liaison with Co-operative Societies Department, S.S. & F.M.S

The Director of the Institute and Major Eaton were also members of the Co-operative Societies' Board and this has also assisted considerably in effecting liaison in connection with various problems concerning rubber small-holdings.

In particular, advice and assistance has been rendered by the Institute in connection with the establishment of co-operative factories and smoke houses for smallholders, with the object of endeavouring to improve the quality of the rubber prepared, particularly by Malay smallholders. A scheme has been started to inaugurate such co-operative factories and it is anticipated that two or more will be in operation during 1930.

Film Propaganda

During the year considerable attention was devoted to the question of film propaganda among small-holders, for the purpose of improving rubber and other forms of cultivation. By the end of the year a scheme had been worked out and approved by the Government and by the Board of the Institute for collaboration between the Department of Agriculture, S.S. & F.M.S., the Co-operative Societies Department, S.S. & F.M.S., and this Institute in the preparation and presentation of films, exhibits and lectures.

The provision of a motor van with the necessary film projection apparatus has been approved and money voted for the purpose; it is hoped to inaugurate the scheme during 1930. It is considered that propaganda of this nature will result in improved conditions on small-holdings and in the preparation of a better product for the market; it should also result in increased market prices for small-holdings' rubber.

Liaison with London Advisory Committee

A memorandum prepared by the Acting Director was approved by the Board and submitted to the London Advisory Committee, in relation to co-operation and liaison with various organisations in Great Britain, including the Research Association of British Rubber Manufacturers, the Rubber Research Scheme of Ceylon (including the work carried out on behalf of Ceylon at the Imperial Institute), the Imperial Bureau of Mycology, and the Rothamsted Experiment Station and other bodies. A sub-committee of the London Advisory Committee of the Institute has been formed to consider the proposals contained in the memorandum.

A satisfactory scheme may take some time to elaborate, especially in view of the fact that the Rubber Research Scheme of Ceylon is under re-organisation, with the object of placing it on a basis similar to that adopted in Malaya, viz., the provision of funds, by means of a cess on all rubber exported from Ceylon, while the Research Association of British Rubber Manufacturers is in a state of uncertainty on account of the fact that the bill introduced into Parliament with the object of imposing a cess on all raw rubber consumed by rubber manufacturers in Great Britain has not yet been passed.

Advisory Work.

As in the report for 1928 and the initial period of organisation, advisory work on behalf of estates has interfered considerably with research programmes.

Although in some respects this is to be regretted, it must be realised that the plantation rubber industry is and will be for some period in a state of flux, owing to the problems facing the industry.

I refer particularly to such problems as manuring, budding and seed selection, re-planting and rejuvenation of rubber areas.

A considerable proportion of such advisory work may be considered as applied research, since it is anticipated that useful and valuable results will be obtained from the work which is now being carried out on many estates.

These problems are presenting many new factors which require investigation and, as in the early days of the industry, practice may have to precede scientific development, which is necessarily slower.

As far as the work of the Institute is concerned, however, it is hoped and anticipated that the re-organisation of the Field Division and the appointment of a Chief Field Officer will relieve the Research Divisions of a considerable amount of correspondence and visits in connection with such advisory work. It is, however, inadvisable and undesirable entirely to divorce Research Divisions from such work, since a broad aspect of the needs of the industry can only be realised by close contact between the Research Divisions and estates.

The amount of such work can be gauged by reference to the list of enquiries and estate visits attached as an appendix to this report.

Altogether 3,972 letters were received which included 2,821 estate enquiries on planting problems. By reference to the Annual Report for 1928, it will be seen that this number is approximately equal to the total number received for the period November 1926—December 1928, that is the immediately preceding period of over twice the length.

In this connection, it is of interest to note the categories in which the majority of the enquiries are included. These are as follows:—

Enquiries in connection with budding problems	...	547
Enquiries in connection with manuring	...	323
Enquiries in connection with investigation of soil samples	...	222
Enquiries in connection with fungus diseases	...	246
Enquiries in connection with the preparation of or defects in smoked sheet	...	340
Total,	...	1,678

These illustrate the interest that is being taken in the problems referred to above and, from the work carried out by the estates concerned, an increase of such work may be anticipated for some years, since new factors are bound to arise.

Comments on the above will be included in observations on the research investigations carried out by the different divisions.

A summary of the principal activities of the various divisions is given in the following pages. A logical sequence has been followed, commencing with investigations on soils and fertilizers, botanical problems in connection with the improvement of planting material, diseases of the rubber tree and ending with chemical investigations on the raw products—latex and rubber.

Soil Investigations, Soil Conservation and Manuring.

The intense interest that has been taken in the improvement of yields by the planting of budded material or selected seed, is also reflected in methods of improving yields of existing areas by means of manuring, soil conservation and the cultivation of cover crops. This is indicated also by the number of enquiries received in connection with manurial trials and requests for soil analyses received by the Institute. It must be emphasized however that our knowledge and methods of soil investigation are not sufficiently advanced, particularly in connection with the cultivation of permanent crops and of rubber in particular, to enable the soil scientist to make definite recommendations in many cases from the results of a soil analysis alone. This is particularly emphasized on account of the amount of work involved in such an analysis in comparison with its probable

value at the present time. On this account, as is indicated in the report by the Head of the Soils Division, short and rapid methods of analysis are being investigated, while valuable information in regard to probable soil deficiencies can be often obtained from observations in the field made by trained scientific observers. This applies in many cases to deficiencies in nitrogen and potash.

A further complication arises in that, even when a deficiency in the soil of one or more of the necessary plant food constituents has been indicated, there may be other factors which will render the addition of such deficient constituents inoperative or uneconomical.

Particularly is this the case at the present time in connection with a number of very poor areas of rubber, on which advice on manuring or rejuvenation is sought. In many instances the character of these areas, the complete loss of top soil and humus resulting in stunted trees with sparse foliage, renders them uneconomic for manuring and, although improvement could be effected, it would be so protracted that it would be unlikely to show a remunerative return. The only solution on such bad areas is to endeavour to establish a cover crop, such as *Mimosa invisa*, and to allow the land to recover and the soil to be rejuvenated at the least cost. In the worst areas, replanting with budded material should be resorted to, which clears the way for thorough re-conditioning. Needless to state, it is impossible to say how long a period must elapse before a particular soil can be re-conditioned. In many instances, it will be undoubtedly more economical to replant with high yielding material, using artificial fertilizers to improve the soil and to stimulate growth, than to manure the existing stand of low yielding trees.

The problem of replanting is also discussed later in connection with root diseases of mature rubber.

Soil Conservation

Ideas in regard to methods of conserving the rainfall and prevention of soil movement are continuing to progress.

Even on flat areas with porous soils, it is recognised that bunding is of great value and the system has been adopted at the Experiment Station of the Institute. Very intensive bunding is now practised in Sumatra and most of the rainfall is being conserved and percolates through the soil on which it falls. Pits are dug only in order to provide soil for the construction of the bunds.

Soil Bacteriology

The importance of the soil fauna and flora, particularly fungi and bacteria, is now being realised to an increasingly great extent and investigation of the problems of their relationships to the humus

or organic constituents of the soil, is essential. This applies especially to tropical forest soils which are cleared for the planting of seasonal or perennial economic crops.

Work has been commenced on these problems and also on the value of leguminous and other green cover plants in relation to soil bacteria.

The question of the formation of nodules on leguminous plants grown as green manures, the successful cultivation of such plants, the supply of nitrogen to the soil by means of the organisms which exist in the nodules on their roots and especially the problem of the effect of their continued cultivation as compared with the periodic digging in of the green plant require investigation.

Although a start has been made, it will probably be some time before results of value will be obtained.

Botanical Investigations.

Owing to changes in and shortage of staff the work in the Botanical Division has been handicapped, but considerable progress has been made in connection with various important practical problems.

Budding

During the year, the planting of budded rubber has made rapid strides in Malaya, in respect of areas planted with high yielding material from budwood from the several best known Java and Sumatra clones and also from Malayan clones, particularly those from Prang Besar Estate. This is shown not only by the large number of enquiries received by the Institute from estates for advice and assistance but also by the large imports of budwood and budded stumps into Malaya from the Netherlands East Indies.

In addition to advice and instruction given on estates, a large number of managers, assistants and conductors have visited the Institute or the Experiment Station in order to study the technique of the buddings operations.

The Plant Physiologist (Mr. C. E. T. Mann) has been fully occupied in this connection. At the Experiment Station, a Clone Trial Block of 40 acres was planted towards the end of the year with nine of the best known clones in approximately 1 acre blocks, each block being replicated four times. It is intended on this area to make a comparison of the yielding capacity of these clones and also to obtain data enabling a comparison to be made with results obtained from the same clones throughout Malaya on varying soil types, on which these clones have been planted by different estates, since it is probable that the clones may show differences in adaptability to different soils and different environments.

In addition, Chinese, Malay and Tamil budders have been trained and sent to estates to assist in budding operations.

A start has also been made with the selection of high yielding mother trees from a large number of estates for future planting, since it is obvious that there must be in Malaya material equivalent, if not superior, to the best clones from either Java or Sumatra.

Fifty-eight estates have agreed to co-operate in this work and records are being kept by the estate managers and also checked at the Institute. Only a few trees from each estate will be selected, from which the yield records are at least five times the average of the trees in the particular field from which they are selected.

It is hoped to use budwood from a number of these trees at the next planting season and a block has been reserved for this purpose at the Experiment Station.

In this connection, it is interesting to note that a number of the Sumatra clones are derived from mother trees grown from seed obtained from Malayan estates.

Tapping records are being continued of the Pilmoor Estate clones, derived from mother trees, the records of which were obtained by Messrs. Sanderson and Sutcliffe, at that time officers of the Rubber Growers' Association Research Laboratories (vide Quarterly Journal, R.R.I. Vol. I. Nos. 1, 2 and 3).

Several clones on this estate give very promising results, although the tapping records have not yet covered a sufficiently long period to enable them to be described as "proved" clones.

A number of defective samples of budwood has been received from various purchasers and advice has been given on the defects.

Microscopic investigations have disclosed the causes of the inferiority of the material. Excellent micro-photographs of the early stages of development of budding have been prepared and will be used for a subsequent publication on budding technique to illustrate the anatomical features of the process.

Pollination and Seed Selection

Mr. L. E. Morris has continued his investigations on artificial pollination of flowers from various clones on Pilmoor estate, the results of which are very similar to those obtained during 1928 and which are published in the report of the Botanical Division.

The seeds obtained, together with other specially selected seeds obtained from various sources have been germinated and planted at the Experiment Station and will in due course furnish valuable material for the study and comparison of buddings and seedlings and may provide valuable seed for distribution for future planting.

At the present time, the popular system of planting of high yielding material is that of mixed planting of "proved" buddings, whereas

only a few years ago the planting of mixed buddings and seedlings was advocated. In a short time, the position may have advanced to that of the planting of blocks of single "proved" clones. In fact one or two well known large estates have already adopted this scheme.

At a still later stage selected seeds from areas of high yielding clones will probably be planted from which new buddings will be made.

Thus for many years, in new plantings or for re-planting schemes, the situation, as stated previously, will be changing.

Identification of Clones

In previous years, a certain amount of budded material was planted on a number of estates of which the records in respect of mother trees have been lost. The assistance and advice of the Institute has been sought in connection with subsequent identification of this material.

As will be realised, the work involved is laborious and considerable; in some cases, final identification can only be established by an examination of seeds and these are not yet available. In view of the fact, however, that a number of these clones may not prove to be particularly valuable it is now advised that tapping tests should be carried out, so that time may be saved by the subsequent identification of only such material as has been proved to be promising in respect of yield.

Tapping

Owing to the fact that the Institute has no area of mature rubber available for tapping, it has not been possible to carry out investigations on tapping systems, although a number of problems still remain to be attacked.

In view of proposals which have been put forward any information from estates on the results of experiments on the cessation of tapping on Sundays would be welcome.

Interesting problems on the most economic method of tapping of budded rubber are also arising and it would appear that different clones may have different optimum periods of tapping and resting.

It is still thought by some authorities that the long period allowed for bark renewal (10-12 years in some cases) is not necessary, although more careful tapping of renewed cortex may be essential if the renewal period is reduced. Periodic tapping systems (A.B.C. or A.B.C.D.) are however becoming more general.

A feature of interest in Malaya during the year has been the high yields recorded amounting to 420 lbs. of rubber per acre per annum on large estates and over 500 lbs. per acre on small

holdings. These figures have been estimated by Mr. J. Gordon-Carrie (Deputy Supervisor of Rubber, F.M.S., and Deputy Registrar-General Statistics, S.S.) (Vide Malayan Agricultural Journal, Vol. XVIII, No. 1, January, 1930, p. 40 et seq. Chart C).

A practice which has resulted in higher yields is the reduction of the tapping task, in order to complete tapping earlier in the day. This, as might have been anticipated, in view of the well known fact that a greater flow of latex is obtained in the early morning, has resulted in considerable increases of yield per unit area on a number of estates. The time of tapping is also of importance in connection with the testing of mother trees for the selection of new clones and for a strict comparison of the yields of different clones.

Experiments have been started on methods of stimulating yields over a short period, in connection with the removal of old trees for re-planting. This is a question of some importance since, for economic reasons, it is desirable to obtain as much latex as possible in the shortest period from the trees which are to be removed.

It has been possible to answer a number of enquiries received during the year by a study of the results of experimental work already published. This information, which is not available in many instances on estates, has been collated at the Institute. It should, however, be emphasized that too much importance should not be placed on the results of experiments on a particular estate and all estates are advised to experiment with any particular system which may be recommended as a result of the yields obtained on some other estate.

In connection with tapping problems, the Institute will be glad to receive results of experiments carried out by estate managers for information or publication.

Importation of Budding Material and Special Seed

The importation of budwood, budded stumps and special seed, all from the Netherlands East Indies, is shown by the following figures, for which I am indebted to the Director of Agriculture, S.S. & F.M.S.:—

Budwood	...	142,000 Metres (Approx.)
Budded Stumps	...	119,400 (Approx.)
Special Seeds	...	938,200 (Approx.)

Diseases and Pests.

The report of the Pathological Division indicates the situation in regard to pests and diseases. Owing to changes and shortage of staff, progress in fundamental investigations on diseases has been been retarded.

New Diseases

No new diseases of importance have been recorded, but much further work is required in connection with the treatment of root diseases and also on the relative value of various fungicides for the treatment of diseases.

Fungicides

At present a large number of proprietary fungicides are used and recommended. Many of these are equally effective and recommendations for their use depend chiefly on relative cost. This position is not satisfactory and there is urgent need for a thorough investigation of the relative value of well known fungicidal chemicals compared with proprietary fungicides. This necessitates not only a determination of their fungicidal properties but also their penetrative effect on the parts of the plant treated, since differences in penetration affect their toxic action on the plant itself; this is particularly important in regard to bark renewal on the tapping panel.

Mouldy Rot

The problem of Mouldy Rot caused by the fungus *Sphaeronema fimbriatum* is of particular interest in relation to treatment of the disease by fungicides, since at the present time, cessation of tapping, combined with preventive painting is the standard remedial treatment recommended. This disease, as is well known, is particularly prevalent on small holdings and is spread by means of infected tapping knives, collecting utensils and articles of clothing of the tappers. If cessation of tapping is ordered, proprietors frequently dismiss the tappers, who obtain employment on other holdings and thus spread the disease.

The Institute is collaborating with the Department of Agriculture, S.S. & F.M.S., on this problem, since legislative measures for the control of disease are administered by that Department.

Brown Bast

The investigations carried out by Dr. Rhodes (Biochemist) throw a new light on the origin and incidence of Brown Bast, especially in relation to the work of previous investigators who regard the disease as physiological in character. The results of these investigations which confirms these views have been published in the Quarterly Journal Vol. 2 No. 1. Further work on the isolation method of treatment due to Keuchenius is necessary in connection with some cases of the disease.

More conservative methods of tapping during recent years have considerably reduced the incidence of the disease, but it is possible that the question may assume a new aspect in relation to the tapping of high yielding budded trees.

Secondary Leaf fall due to Oidium

The abnormal leaf fall caused by the mildew fungus, *Oidium Heveae*, became pronounced in certain districts and at the time of writing this report (March 1930) a severe outbreak has followed the intense and rapid wintering of the trees in several districts. This is undoubtedly due to the prolonged dry period during re-foliation and it is anticipated that the outbreak will disappear with the rains.

There is, however, considerable cause for apprehension, since it is possible that with lapse of time the fungus may become more adaptable to the host. Steps have already been taken to purchase a number of power and hand sprayers and dusters in order to ascertain the most suitable type of apparatus for remedial or preventive treatment. It appears not improbable that such apparatus may in due course have to be an essential part of the equipment of estates for dealing with possible outbreaks of this disease.

Diseases and Cover Crops

It is well known that, on new areas in particular, where much felled timber and many stumps are present, root diseases spread with greater rapidity when the soil is under cover crops than when such protection is not provided, owing to the moist conditions and to the fact that these diseases are spread by the root system of the cover crop. Recommendations in respect of the removal of the cover crop and the treatment of the disease must depend on the conditions existing on the affected areas, since it may not be necessary to remove the cover crop on some areas.

Insect Pests

Apart from white ants on certain estates, particularly on peaty areas on which much buried timber exists, no insect pests of importance have been recorded on a large scale, although mites and scale insects have been found to cause frequent damage in nurseries.

Root Disease and Replanting

A problem which is becoming of great importance, especially on old areas of mature trees on which yields of rubber are stationary or decreasing and on which root diseases are very prevalent, is that of replanting.

This is particularly important on estates with no reserve jungle and also on flat lands, which have been thoroughly drained and which are free or comparatively free from root fungi owing to expenditure on treatment in the past. In view of the possibilities of the high yields to be anticipated from budded rubber, the problem is assuming considerable commercial importance, since it is realised that, provided the soil has not deteriorated on account of erosion or other factors, it is an economic proposition to replant such areas. In order not to cause too great a drop in yields, such programmes must be carried out systematically and slowly.

Advantage must also be taken of any method of obtaining during a comparatively short period all the latex which it is possible to extract from the trees which are to be removed. It is possible that before the end of the present year, results of certain experiments now in progress may show that it is possible to remove in a period of about six months an amount of rubber which would in normal circumstances constitute one or even two years' yield on low yielding areas.

Chemical and Bacteriological Investigations on Latex and Rubber.

Fundamental research on latex and the preparation of rubber has also been affected by changes in and shortage of staff.

Progress has, however, been made and two investigations dealing with the effect of moulds on raw rubber and the yellow colouring matter in latex, which were commenced in 1928, were completed and the results have been published.

The following is a summary of the principal problems dealt with during the year:—

White Sole Crepe

The demand for a very pale or white sole crepe is to be regretted since there would appear to be no valid reason other than fashion why slightly yellow sole crepe should be considered inferior, especially when it is realised that, as soon as the sole crepe is used, the pristine white colour is irretrievably lost by the immediate accumulation of dust, dirt or mud.

Fractional coagulation in order to eliminate the yellow tint adds to the cost of preparation and, if a slightly yellow sole crepe were acceptable, the estate output would be nearly 100 per cent of the pale crepe manufactured in the estate factory, as the clippings can be re-machined for the manufacture of a second slightly darker grade of sole crepe.

Investigations carried out during the year have included work on the yellow pigment in latex, which is coagulated or separated with

the first fraction of coagulum in the fractional coagulation of latex for the preparation of such sole crepe. No suitable method other than fractional coagulation has been discovered for the removal of this colour, which has been shown to be due to the presence of carotin, a natural colouring matter present in various plants.

Moulds in Smoked Sheet

Following up observations made by the writer in 1916, investigations have shown that large losses of rubber may occur from attack by the commoner moulds or fungi, if rubber is stored under damp conditions. Free moisture may be present between the sheets of rubber in the cases due to the water formed chemically from the caoutchouc by the fungi. This was observed in an estate sample after prolonged storage during the restriction period.

The results of this investigation, which included also an investigation on so-called "undercured" smoked sheet, that is, sheet showing a white or opaque interior streak or layer, have been published during the year as a Special Bulletin (No. 2.).

Preservation of Latex

Investigations on the preservation and concentration of latex have been continued.

Factory Problems

In connection with immediate practical problems, attention has been given to the width of smoked sheet rubber in relation to the dilution of latex, the depth of coagulating tanks, the distance between partitions in tanks and the width of sheeting machine rolls. It is obvious that within limits, the wider the sheet the greater the factory output per unit time and it would appear advisable wherever possible, especially in the construction of new factories or the installation of new coagulating tanks or sheeting machines, to purchase equipment suitable for the manufacture of a wide sheet.

Although these investigations are not complete, the results obtained indicate that a coagulation tank of 18 inches dept, filled to a depth of 15-16 inches, and the employment of 24 inch roll machines will meet the situation in providing a dry sheet of 18 inches width, which can be packed in the ordinary 19 × 19 × 24 inch packing case, leaving sufficient space for the sheet rubber wrapping layer.

Information from estates indicates that the output may vary from 200 to 650 lbs. of dry sheet per hour in estate factories, with present methods and equipment, with a single battery of machines (three smooth roll and one marking roll machine). Sheet rubber can

be prepared very economically by means of a battery of light machines and a prime mover of low horse power.

As a result of a lecture given by the writer before the Incorporated Society of Planters and of subsequent propaganda, considerable interest is being taken in this problem, both by manufacturers of rubber machinery and coagulation tanks and by estates.

The problem of preparing a wider crepe is also of interest and the writer during visits to Java and Sumatra observed that wide (18 inch) sheets of crepe were being prepared on a number of estates in those countries. This has probably occurred on account of the introduction of wider roll machines for the manufacture of sole crepe.

Air Dried Sheet

Investigations on the preparation of an air-dried sheet as a substitute for smoked sheet are being continued.

The investigation indicates that it may be desirable to add an anti-oxidant to the latex and to dry at a somewhat lower temperature than that employed in the preparation of smoked sheet, since hot-air drying at about 110°-120°Fah. causes a stickiness of the surface of the sheet due probably to oxidation. Similar observations have been made by O'Brien, Chemist to the Rubber Research Scheme, Ceylon.

Smoked Sheet

In connection with the advisory work, it is of interest to note the comparatively large number of enquiries from estates in connection with smoked sheet.

These indicate the greater difficulty in preparing a high quality product to meet the stringent market demand in regard to certain defects—especially the presence of foreign matter due to inefficient straining of latex—compared with the preparation of thin pale crepe.

As is indicated in the report by the Head of the Chemical Division, the problem of bubbles in sheet rubber has received further attention and it has been shown that small quantities of sugar, when added to latex, cause a greater incidence of bubbles due to fermentation and consequent gas formation. Small quantities of carbonates have a similar effect due to the formation of carbon dioxide gas, which cannot readily escape before coagulation is effected or which is adsorbed by the coagulum and subsequently released at the higher temperature of the smoke house.

Advice has been sought and given in connection with the design and construction of smoke houses, the consumption of wood fuel for smoking rubber, and the design and construction of crepe drying sheds.

In this connection, it is of interest to note that in Java, most of the crepe drying sheds are provided with hot water circulation for use at night and during the wet monsoon season. No artificial methods of air-drying are at present in use in Malaya, although a number of drying sheds leave much to be desired from the point of view of efficient ventilation and location.

Biochemical Study of Latex

Work has been started on the isolation and identification of the non-caoutchouc constituents of latex and these will be utilised also in connection with a study of their effects on the quality and variability of raw rubber and the changes induced by bacterial action.

Bacteriology of Latex

Further light has been thrown on the nature and activities of the organism in latex responsible for causing natural coagulation, especially under anaerobic conditions.

An organism, which appears to be very widespread in Malaya, and which is probably the same as the organism responsible for similar changes in latex in the Netherlands East Indies and Indo-China, has been isolated and studied by Dr. Corbet (Bacteriologist). The investigation has confirmed previous work and theories on the bacterial coagulation of latex.

Owing to the exigencies of work in connection with problems of soil bacteria, this work has had to be curtailed.

New Methods of Preparation

No new methods of preparation of particular value have been discovered. A second plant for the manufacture of Revertex (concentrated latex prepared by the evaporation of latex to which an alkali and a protective colloid are added) has been erected on another estate in Malaya.

The concentration of latex by the centrifugal process (Utermark process) is still being carried out in modified Alfa-Laval centrifuges on one estate.

The preparation of slab rubber on an estate in Johore has been discontinued, since this estate, which was formerly supplying rubber to the rubber manufacturing firm which owned it, has now been sold to another company.

The export of preserved (ammoniated) latex from a large number of estates in Selangor ceased at the end of the year, owing to the company that purchased this latex on a large scale closing its contracts. Other estates however are continuing to export latex to Europe and other countries.

The manufacture of sole crepe is carried out on a number of estates and the Malayan product, which at present fetches about 8d. per lb. premium over the market price of standard smoked sheet and pale crepe, is in good demand.

Investigations are being carried out in connection with the substitution of an air-dried sheet for smoked sheets, but it may be some time before the scarcity of wood fuel for smoking will affect the substitution. In any case some other form of fuel will have to be substituted, since it is not possible to dry sheet rubber at normal air temperature in a reasonable period.

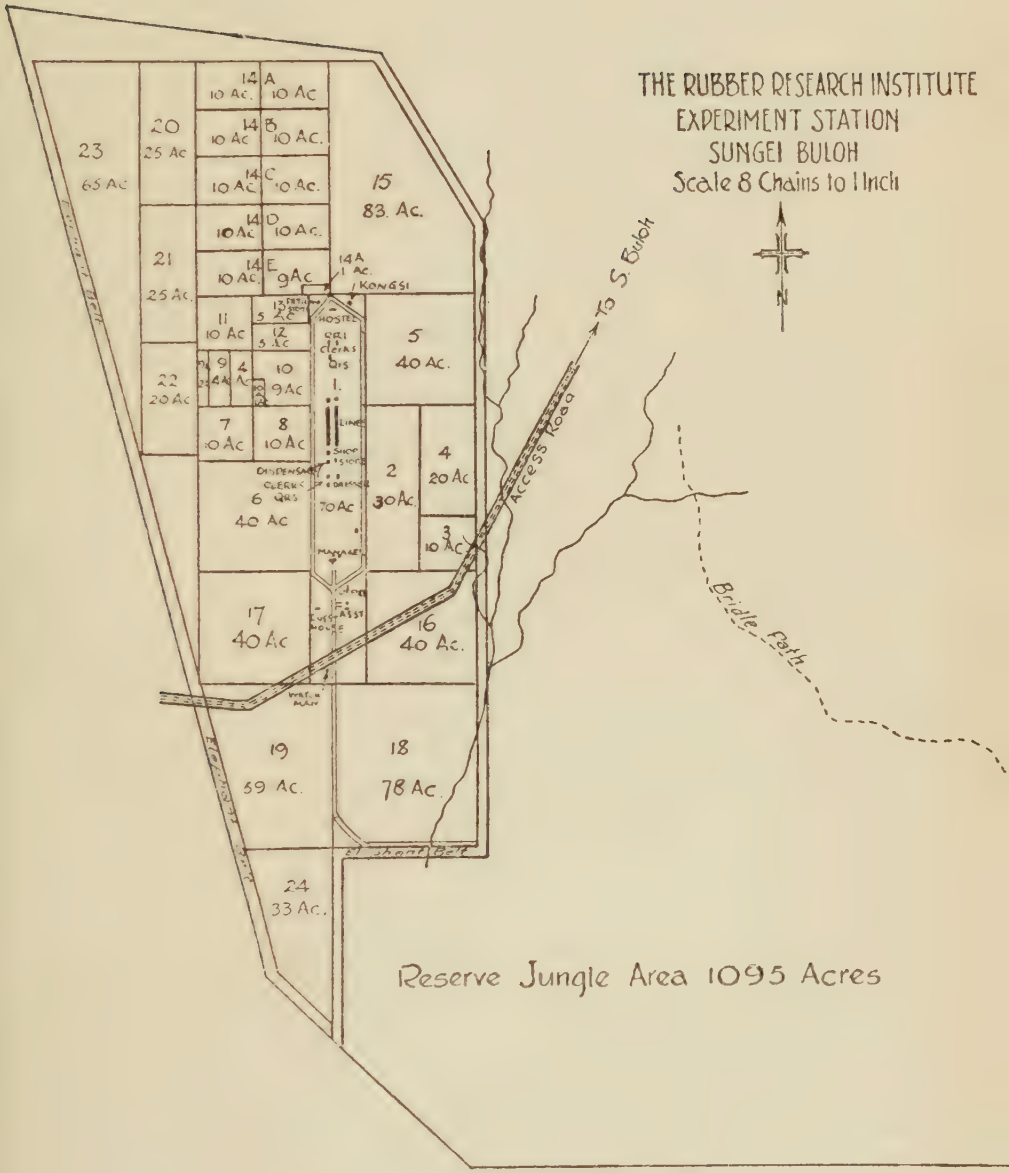
From time to time new methods of preparation are submitted to the Institute for advice and report but no method of particular value has been received.

Experiment Station.

The Annual Report by the Manager indicates the considerable progress that has been made in felling, burning, clearing and planting.

The total area acquired is approximately 2,000 acres, of which 905 acres had been opened at the end of the year. This includes 571½ acres planted, 70 acres reserved for building site and 67 acres felled as an elephant belt (2 chains wide) surrounding the opened area. The details of the various blocks which are shown on the plan reproduced on the opposite page are as follows:—

No. of Block.	Area. (Acres)	Area planted (Acres)	Allocation or Experiment.
1	70	—	... Building site.
2	30	30 (approx)	Collection of seedlings from special seed from historical trees in Malaya, Ceylon and Java.
3	10	8	... For future budding.
4	20	15½ (approx)	(a) 10 acres Pilmoor Estate (1928) crosses and controls. (b) 5 acres nursery. (c) 5 acres twin seedlings. (d) Comparison of seed at stake and germinated seed.
5	40	40	... Clone Trial Block for the comparison of nine of the principal Malayan, Java and Sumatra Clones.


THE RUBBER RESEARCH INSTITUTE
EXPERIMENT STATION
SUNGEI BULOH
Scale 8 Chains to 1 Inch
N
To S. Buloh
Access Road
Bridle Path
Reserve Jungle Area 1095 Acres
23
65 Ac
20
25 Ac
14 A
10 Ac
14 B
10 Ac
14 C
10 Ac
14 D
10 Ac
14 E
9 Ac
15
83. Ac.
21
25 Ac.
14 A
1 Ac.
KONGSI
HOSTEL
11
10 Ac
12
5 Ac
5
40 Ac.
22
20 Ac
10
9 Ac
7
10 Ac
8
10 Ac
2
30 Ac.
4
20 Ac
3
10 Ac
6 QRS
40 Ac
70 Ac
17
40 Ac
16
40 Ac.
19
59 Ac.
18
78 Ac.
24
33 Ac.

6	40	40	... Manurial Experiment (five different treatments with control plots—replicated six times).
7	10	10	... Comparison of seed at stake, basket plants and stumps and crowbar planting of stumps. Uncleared area with cover crops (3 species). To determine the incidence of root disease in an uncleared area under different methods of planting, and the relation of cover crops to disease under these conditions.
8	10	10	... Experiment as in Block 7 but area clean-cleared.
9A	2	—	... Fallow for 5 years—no clearing, clean-weeded. To determine the influence of long exposure on longevity of soil and wood-destroying fungi and on the chemical and physical nature of soil.
9B	8	8	... Basket plants. Immunity to disease test.
10	9	9	... Seed at stake to provide high yielding rubber for experiments on root disease control and immunity to root diseases.
10A	1	1	... Seed at stake. Cover crops (Centrosema, Calapogonium and Vigna mixed). To determine various disease factors.
11	10	10	... Stumps, basket plants and seed at stake. Comparison with smallholdings' conditions. Secondary jungle. No weeding except removal of lallang.
12	5	5	... Nurseries. Study of diseases and the spacing of seedlings.
13A	2½	2½	... Cover plant nurseries. Collection of different varieties of cover plants.
13B	2½	2½	... Collection of different cover crops planted with rubber (seed at stake).
14	—	—	... Density of planting experiment.
A	20	—	... 435 plants per acre.
B	20	—	... 302 plants per acre.
C	20	—	... 222 ,, ,, ,,
D	20	—	... 108 ,, ,, ,,
E	19	—	... 48 ,, ,, ,,

F	1	1	...	Jungle felled and cleared without burning to ascertain the effect on the growth of rubber trees.
15	83	33	...	Comparison of new Malayan clones with a standard clone. Budding will be carried out at the end of 1930.
16	40	31 (approx)		(1) Pilmoor (1929) crosses and controls. (2 Families of individual tree seedlings for variability tests.
17	40	23 (approx)		(1) Manurial tests for optimum amount and time of application. Buddings and Seedlings. (2) Cover crop experiments. Shading, manuring, digging in of cover crops and effect of rubber trees on cover crop. (3) Mulching and manuring of nurseries.
18	78	66 (approx)		Planted with stumps for future tapping experiments on budded trees.
19		64		(1) Experiment with natural covers. (2) Artificial irrigation. (3) Silt pitting and bunding on slopes.
20	25	25	...	Study of soil flora, under change of cover crops, plus effect of annual digging.
21	25	25	...	Effect of soil disinfectants and fungicides.
22	20	(Ready for planting)		(1) Non-Hevea species of rubber trees. (2) Rubber after Tapioca cultivation. (3) Rubber and Coffee.
23	65	,,	...	Treatment of soil with varying quantities of lime (1 to 5 tons per acre).
24	33	33	...	Experiments with terracing and cover plants on steep land.

Except where otherwise stated, seed from high yielding estate areas was used as the normal planting material.

On a number of the pathological plots for the study of root diseases under different conditions of treatment, budding of some of the planting material will be carried out. This applies also to areas allocated to the Soils Division for various experiments.

It is too early to make any pronouncement on the results of any of the experimental work with the exception of the manurial trials on Block 6. One paper published by Dr. Haines, Head of the Soils Division (see Quarterly Journal Vol. I. No. 4) already indicates the value of treatment of young rubber with cattle manure on the particular type of soil on this block.

It appears probable that the advantages of artificial fertilizers will be shown later. On the particularly porous soil on the greater part of the area already opened, the great advantage of planting during the early part of the rainy seasons is also indicated. There would appear to be a critical stage in the growth of the young plants, depending on the development of the root system, at which growth is definitely retarded if a dry period sets in at this stage.

Although it was not possible to plant the Clone Trial Block (Block 5) till late in the year, the operations of budding and transplanting can be considered very successful. This block should prove of great value for a comparison of some of the best available clones at present in existence, although it will be necessary also to compare the results with those obtained for these clones on various estates on different soil types.

A large number of special seeds from various sources together with seed obtained by Mr. Morris (Geneticist) from the artificial pollination of promising clones on Pilmoor Estate, by various combinations of crosses, has been planted for future study of yields of seedlings and comparison with buddings.

An area has been reserved for new Malayan clones, which the Institute hopes to establish from high yielding mother trees on estates in various parts of the peninsula. Records of yields of such trees are being kept and it is hoped that it will be possible to plant this area during the next planting season (October-December 1930).

Preliminary records which may be of value should be available during 1930 in connection with the comparison of the effect of various cover crops on the growth of young rubber trees, with the growth on clean-weeded plots, and also with the type of growth normally existing under small-holdings' conditions on which secondary jungle (belukar) and weeds, except lallang grass, have been allowed to develop.

Bunding has been carried out on the whole of the flat area and has proved of considerable value in conserving the rainfall and in preventing soil movement. Cover crops have also been successfully established on many of the blocks.

Good progress has been made with the buildings and road programme, while the Government road through the estate is now completed; this facilitates transport of materials and renders access to the station from Kuala Lumpur comparatively easy.

The reserve jungle (approximately 1095 acres) was renticed and surveyed during the year and an examination of the area was carried out by the Acting Director, accompanied by the Visiting Agent (Mr. D. S. Gardner), Dr. Haines (Head of the Soils Division), Dr. Flint (Soils Chemist), Mr. L. E. Morris (Geneticist) and Mr. H. W. Foston (Manager).

A report on this area indicated its suitability for further extensions.

Some difficulty has been experienced owing to health conditions on the Station, but it is anticipated that this will be improved by the measures which have been already adopted and by other measures which are in contemplation.

Visitors to the Experiment Station are welcomed and it is hoped later to fix a definite date in every month for special visits. Applications to visit should be addressed to the Director of the Institute.

Conferences.

The Director and the Heads of the Botanical, Chemical, Pathological and Soils Divisions were appointed as delegates to attend the Fourth Pacific Science Congress held in Java during May.

Previous to this Congress a Rubber Conference was convened by Prof. Dr. O. de Vries, Director, Proefstation voor Rubber, Buitenzorg, Java, at which the above delegates were also present and contributed papers and discussions.

The value of the Rubber Conference and the visits arranged by our Dutch scientific colleagues was considerable. Many ideas were clarified and much valuable information was collected.

A uniform system of testing of raw rubber by the Rubber Proefstation in Java, the Rubber Research Scheme of Ceylon (at the Imperial Institute Rubber Testing Laboratories) and by this Institute was approved and adopted. In this connection thanks are due particularly to Mr. B. D. Porritt, Director of the Research Association of British Rubber Manufacturers and Mr. G. R. Martin, Superintendent of the Rubber Testing Laboratory at the Imperial Institute, for a valuable compilation of existing methods, which had been prepared previous to the Conference and which was available as a basis for the discussion of the problem.

In addition, papers were read and discussions took place on diseases of the rubber tree, manuring problems in connection with rubber, and improvement in yield by means of vegetative reproduction (budding) and seed selection.

Our thanks are due to the organisers of this Rubber Conference and to the Managers of a number of estates in Java for the facilities afforded in visiting estates and for the hospitality received.

Rubber was also included among the subjects for discussion in the Agricultural Section of the Pacific Science Congress while a number of very interesting visits were arranged in connection with the Congress.

At this Congress, it was decided to organise a Far Eastern Tropical Agricultural Association for the periodic discussion of agricultural problems affecting eastern tropical countries. This was approved by the Council of the Pacific Science Congress.

Agricultural Shows.

Exhibits were staged at two district Agri-Horticultural Shows viz. at Telok Datoh in the Kuala Langat district, Selangor, and at Karak in West Pahang.

In addition to the collection of exhibits sent to these shows, budgrafting demonstrations were carried out.

Lectures and Staff Colloquia.

The following lectures were delivered during the year:—

Director and Acting Director	...	3
Botanical Division	...	5
Chemical Division	...	2
Soils Division	...	6
		16

These lectures were delivered before the following bodies:—

Planters' Associations.

Johore Planters' Association (Johore Bahru)	...	1
Johore Planters' Association (Rengam)	...	1
Kuala Lumpur Planters' Association	...	1
Kuantan Planters' Association	...	1
Malacca Planters' Association	...	2
Muar Planters' Association	...	1
Malay Peninsula Agricultural Association	...	1

Incorporated Society of Planters.

Annual Conference (Ipoh)	...	2
Nilai-Labu Branch	...	1
Sitiawan Branch	...	1
Taiping Branch	...	3
Teluk Anson Branch	...	1
Total	...	16

The following subjects were dealt with at the above lectures:—

1. The Inter-dependence of Technical Education and Research in Agricultural Development.
5. The Objects and Aims of Plant Breeding in Rubber Cultivation.
6. Budding.
7. The Early Diagnosis of high yielding Rubber Plants.
8. The Principles of Plant Breeding applied to Rubber.
9. Factory Economics in the Preparation of Raw Rubber.
10. Factory Practice and Defects in Raw Rubber.
11. Defects in Raw Rubber.
2. Soils and Manures.
3. The Role of Humus in Tropical Soil Management.
4. Soils and the Significance of Soil Analyses.

These lectures were well attended and in many cases gave rise to useful discussions.

In addition to the above, Major Eaton gave a lecture on "The Chemist and the Rubber Industry" and Dr. Flint gave a lecture on Micro-chemistry before the Malayan Section of the Institute of Chemistry of Great Britain and Ireland.

Eight colloquia were held at which various members of the staff gave a resumé of certain work in progress in their respective divisions and the work was discussed.

The following is a list of the colloquia with the subjects discussed.

Progress of Root Disease Investigations	...	by A. R. Sanderson.
Progress of Investigations on Artificial Pollination and Seed Selection Work	...	by L. E. Morris.
Progress of Investigations on the Bacteriology of Latex	...	by A. S. Corbet.
Progress of Budding Investigations	...	by C. E. T. Mann.
Investigations on Coagulation Phenomena in Latex	...	by R. G. Fullerton.
Experimental Investigations on the Capillary Properties of Soil	...	by W. B. Haines.
Biochemical Investigations on Brown Bast	...	by E. Rhodes.
Manurial Experiments on Rubber	...	by C. F. Flint.

Members of the Board and members of the staff of the Department of Agriculture attended some of these colloquia. Other occasional visitors (planters, travelling representatives) were also welcomed. Mr. Eric Macfadyen of Messrs. Harrisons & Crosfield, London, who was visiting Malaya, attended the colloquium on Manurial Experiments on Rubber.

Publications.

The following publications were prepared and issued during the year:—

Quarterly Journal—Four numbers (Nos. 1 and 2 were combined as one issue.)

Annual Report for 1928 and Initial Period of Organisation.

Bulletin No. 1, Natural Coagulation of Hevea Latex.

Bulletin No. 2, A Study of the Effect of Damp Storage on Raw Rubber.

A Manual on "The Preparation of Raw Rubber" was prepared for translation into Chinese. This was published as a double number of the Chinese Agricultural Journal (Vol. III, Nos. 1 and 2) issued by the Department of Agriculture, S.S. & F.M.S.

Visitors.

A feature of the year was the large number of visitors to the Institute, especially planters who came to discuss various problems connected with estate practice.

Special visitors included His Excellency Sir Hugh Clifford, G.C.M.G., G.B.E., (Governor of the Straits Settlements and High Commissioner of the Malay States), Sir William Peel, K.B.E., C.M.G., (Chief Secretary to Government, Federated Malay States), Mr. Eric Macfadyen (Harrisons & Crosfield, London), Mr. F. A. Hinde (Managing Director, Avon Tyre and Rubber Company, England), Mr. L. Lord (Economic Botanist, Department of Agriculture, Ceylon), Mr. J. Grantham (Director of Research, Holland American Plantations Inc., Sumatra), Dr. P. J. S. Cramer (Consulting Botanist, Dunlop Rubber Plantations, late of Department of Agriculture, Commerce and Industries, Netherlands East Indies, Java). Dr. O. Schreiner and Dr. R. D. Rands (U.S.A. Department of Agriculture, Washington) and Mr. Maurice Holland, Director of Engineering and Industrial Research, National Research Council, U.S.A.

A delegation of the Chairman and members of the Council of the Planters' Association of Malaya and members of the Kajang Branch of the Incorporated Society of Planters also paid special visits.

General.

I wish to express my thanks to all members of both the senior and junior staff for their enthusiasm and loyal support in the latter part of the year during which I have acted as Director.

It would be invidious to mention names, but a number of officers have devoted much time, beyond the normal office hours to the work of the Institute, while the clerical staff has also on many occasions worked overtime in order to cope with the numerous enquiries received.

APPENDIX.

Analysis of Enquiries on Rubber Estate Problems.

The following table summarises the principal enquiries received by the Institute during the year.

Botanical.

Budding (Estate Enquiries)	...	441	
,, (General)	...	109	
Clone Purchases	...	87	
Selection of Mother Trees	...	84	
Budwood and Seed-Methods of Packing	...	9	
Pollination	...	4	
Seed (Germination)	...	4	
do. (Introduction for Experimental Purposes)	...	9	
Estate Isolation Areas	...	4	
Seed Selection	...	22	
Replanting	...	5	
Cultivation	...	4	
Planting (General)	...	21	
Tapping	...	64	
Latex Vessel Rings	...	7	
Planting Material-Requests for	...	6	
Yields, Estate Records	...	9	
Rubber Acreage and Production-Statistics	...	10	
Non-Hevea Rubber Producing Plants	...	9	
Cover Plants	...	23	
Catch Crops	...	4	935

Chemical.

Latex (General)	...	5	
do. (Analysis of)	...	49	
do. Preservation	...	42	
do. Concentration	...	7	
do. Determination of "Dry Rubber" content and examination of Latexometers	...	36	
Coagulants of Latex	...	12	
Anti-oxidants of Latex	...	8	
Anti-coagulants of Latex	...	14	
Rubber Preparation (General)	..	5	

Smoked Sheet	...	254	
Smoke Houses	...	88	
Air-dried Sheet	...	5	
Crepe—First Grade	...	33	
Crepe—Lower Grades	...	28	
Sole Crepe	...	9	
Machinery	...	26	
Coagulating Tanks and Pans	...	52	
Vulcanisation Machinery and Apparatus	...	9	
Vulcanisation of Rubber	...	31	
Fine Hard Para Rubber	...	12	
Vulcanisation Accelerators	...	1	
Non-Hevea Rubber—Examination of	...	1	
Rubber Seed Oil	...	7	734
		...	1669

PATHOLOGICAL.

Fungus diseases of Rubber	...	246	
Brown Bast	...	36	
Diseases and Pest control	...	13	
Epiphytes of Rubber	...	1	
Die-back—Old Rubber	...	9	
Fungicides	...	35	
Abnormal growths on Hevea	...	3	
Injury by external agents	...	88	
Tree Operations	...	15	
Resistance and Immunity	...	2	
Seed Bed and Nursery Diseases	...	4	
Spraying and Spraying Equipment	...	6	
Diseases of Buddings (Fungi)	...	3	
Replanting	...	5	
Thinning	...	2	
Cover Plants	...	10	478

SOILS.

Manuring	...	328
Soil samples—Investigation of	...	222
Soil Conservation	...	12
Drainage	...	3
Fertilizers	...	37
Bacteriological samples	...	3
Cultivation	...	6

Replanting	...	10	
Tree Operations	...	1	
Cover Plants	...	52	674
Total.	...		2,821

Summary of Visits to Estates.

	Number of Estates visited.	Number of visits paid.
Acting Director	... 14	... 16
Botanical Division	... 85	... 301
Chemical Division	... 32	... 38
Pathological Division	... 45	... 65
Soils Division	... 92	... 99

The above list excludes all visits to the Institute Experiment Station, but includes visits to estates on which experimental investigations, including tapping tests on budded trees and manurial trials, are being carried out. This explains the high figures under "Number of Visits paid," compared with the "Number of Estates visited," especially by officers of the Botanical Division.

B. J. Eaton,
Acting Director.

March, 1930.

ANNUAL REPORT 1929.

SOILS DIVISION.

The year 1929 in the Soils Divisions has been marked mainly by the establishment of the routine analytical work on a sound footing. In other regards the situation has been dominated by the circumstance that the whole of the advisory and field work dealing with soils has fallen to the two Research Officers of the Division. While this has broadened their contact with estate problems and extended their ideas for future work, it has also necessarily hampered the development of experimental and other internal work.

Advisory Work.

Advisory work has entailed dealing with some 680 letter enquiries and making 97 visits to estates in all parts of the country. Of these visits, 52 were made by the Head of the Division and the rest by the Soils Chemist, Dr. C. F. Flint. These do not include visits made on special trips nor those made to the Experiment Station of the Institute.

The subjects of enquiry have covered a very wide range, but, as was the case last year, the greater number have been concerned with the endeavours to improve poor and deteriorated stands of rubber by means of manuring. The number of estates experimenting along these lines has greatly increased during the year, but from the nature of the case there has not been added much in the way of fresh conclusions. The data so far collected by the Institute are being summarised in a separate publication. The main lesson which it is desirable to emphasise here is the importance of manuring in time if a quick response is to be secured. The years allowed to slide, while the trees go backward and the yields decline, must be balanced by years of waiting for the trees to recover a normal balance under the improved condition induced by manuring, before a finaicial return can be looked for. Since most areas so far chosen for experiments come into such a category they have not yet reached the stage of giving determinative results. Several experiments on younger areas have, however, given most promising returns. Symptoms of approaching deterioration are not difficult to read, and they often appear long before there are serious reductions in yields. It may therefore be urged that manuring as an economic proposition is much more satisfactorily applied when the signs first appear, than applied when deterioration has become an established fact and is causing alarm by serious reduction in yield.

Arising out of the slow or doubtful returns from manuring on the oldest areas—and it must be recognised how severe a history these have suffered—there is an increasing interest in replanting schemes, and several estates are carrying out small experiments. The limiting factor as regards yield is always the bad condition of the bark, so that the attainment of a new panel of tappable bark is the essence of the problem, whether it is one renewed on the same trees under better conditions of nutrition or one grown upon a new tree altogether. It is not unreasonable, therefore, to consider the merits of a scheme which will produce bark on a new and more vigorous stand of high-yielding (budded) trees against expensive manuring schemes which must wait in any case for a similar length of time for financial return. The first scheme is more certain than the second, even if it is more expensive. One of the advantages offered by replanting is the better opportunity to recondition the soil by green manuring and cultivation. Also it may be pointed out that manuring expenditure on a stand of high-yielding rubber, supposing such to be necessary to yield maintenance, means a smaller outlay per lb. of rubber produced than in the case of the best improvements which can be expected in old stands of mixed material.

In connection with manuring advice there are two reasons for urging managements to arrange their plans well in advance, rather than to wait until the leaf fall begins and reminds them that the manuring season is at hand. In the first place, diagnosis of the needs of a particular case depends very much on the signs shown by the normal leaf canopy. The absence of this for a considerable period before, during and after wintering makes a visit of advice of considerably less worth during that time. In the second place it is impossible for the staff to condense into a few weeks the advisory work which might, with foresight, be distributed over the year. Both deterioration and recovery are slow processes, so that there is no inherent urgency in the case.

Investigation of Soil Samples.

The beginning of the year marked the appointment of Mr. K. S. Pillay, as Assistant Chemist, and it was possible for the first time so to arrange the laboratory work that prompt attention could be given to the routine chemical analysis of the samples being submitted. This entailed a great deal of preliminary work for the establishment and standardisation of methods. This was completely carried through by Dr. Flint, whose previous researches formed a valuable basis for the selection of the quickest and most modern methods.

During the year 406 soil samples were received, and 6 other samples of various kinds were examined. Of the soil samples 312 were subjected to mechanical analysis and 256 to chemical analysis.

The mechanical analysis has been in the hands of Mr. O. C. K. Raman. The chemical work involved 774 accurate quantitative determinations. The number of separate reports made by the Division on groups of samples was 83.

In the main the analyses show a great similarity. A characteristic of the mechanical constitution is the smallness of the silt fraction. The value for silt is generally under 5 per cent. The clay content varies greatly, and when high the soil is always impervious. The signal exception to this rule is an area round Kuantan of Dolerite origin. The soil here is pure clay (over 90 per cent) but has such a granular texture from its flocculated state that the heaviest rains percolate immediately and no surface wash occurs even in the course of years.

Chemical analyses usually show sufficiently high phosphate figures (over 0.1 per cent in the acid extract) but very low potash figures, the latter being especially noticeable in more sandy soils. The samples examined were mainly from areas where the rubber was poor and so they do not form a truly representative set, but as regards their mineral constitution the remarks made will be generally applicable. The potassium is often under 0.01 per cent. This has led to the recommendation of potash manuring in a large number of cases during the year. Observations on cover crops treated with wood ash, show, by the quick response, that potash is often a distinct deficiency. The nitrogen figure is very variable, and it is very difficult to estimate from it whether the rubber needs nitrogen manuring. Exposure and continued weeding have in some cases so reduced the organic content of the soil, that the rubber roots form the only organic matter in a sample. The carbon-nitrogen ratio is usually much in excess of the normal value of 10 or 12, indicating that a large part of the organic matter (twigs, etc.) is present in very early stages of decomposition, or, conversely, that the end product of decay rapidly disappears. In some cases the presence of residues of charcoal from the original burn-off of the forest gives a very unusual ratio, even after the lapse of years.

It is necessary to repeat the remarks made last year regarding care in sending soil samples from estates. The service asked for entails so much time and care for its proper performance that it is reasonable to ask that those who propose to send samples should pay careful attention to the following points.

1. To ascertain that their problem is one to whose solution a soil analysis is likely to make a definite contribution.

2. To furnish together with the samples a clear statement of the problem with all relevant details as to local conditions. Details as to drainage, the depth of soil, previous history of the site and appearance of foliage are specially important.

3. To limit the number of samples to the minimum required to cover the case.

The position as regards the general organisation of the work in the laboratory has been to a great extent conditioned by the relatively short period of the Institute's activities. A great deal of time is consumed in setting up new apparatus and testing methods which are proposed for use in future researches. Such work is not immediately productive, and may be likened to the preparation which a workman will make in sharpening his tools and erecting accessories before commencing the job in hand. A great deal of such work has fallen to the share of Dr. C. F. Flint during the period under review.

Meteorological.

The records referred to last year have been continued, the care of the instruments being in the hands of R. P. Alwar. Owing to the regularity of the climate there is little that is novel to add to last year's report.

Radiation.—The total energy received as radiation from the sun was sligthly less than last year (by about 2½ per cent), being 154,200 calories per cm². This gives an average daily value of 423 calories per cm². There was a loss of record on a small number of days, corrected for by averaging. The highest value of radiation for a day was on February 28th giving 622 calories per cm². The lowest value was 131 calories on February 11th.

The soil temperature records were continued, under a growing cover of Vigna, for part of the year.

Rainfall.—The large gauge readings showed the following monthly values.

Month.		*Rainfall. Inches.*	*Number of rain days.*
January	...	5.304	12
February	...	2.401	15
March	...	10.778	21
April	...	18.647	23
May	...	7.353	13
June	...	7.980	13
July	...	2.511	7
August	...	1.965	8
September	...	6.925	19
October	...	9.959	20
November	...	16.209	23
December	...	4.473	13
Totals	...	94.505	187

The heaviest shower fell on June 4th reaching a total of 3.968 inches. This followed 11 days' drought. The driest periods were during June and July. In late May and early June there were 15 days with a total of only 0.047 inches of rain. In late June and early July another period of 14 days occurred with rain on one day only (0.095 ins.) Again between July 19th and August 4th there were 17 days broken by two rain-days only with a total of 0.061 inches.

The greatest intensity of rain was recorded on December 20th. During a shower which totalled 1.726 inches an intensity of 8.4 inches per hour was reached (= 0.14 in. or 3.56 mm. per min.). On a good many occasions, values only a little smaller were recorded.

A comparison of the rainfall figures at the laboratory with those at the Experimental Station 8 miles away, showed some 50 per cent excess for the latter location.

A fuller discussion of the meteorological data is reserved for separate publication.

Experiment Station.

The Block 6 manuring experiment has made good progress; a second dressing of fertilisers was applied during the July-August dry weather. Two series of measurements of growth were made (September and December), of which a discussion is published in the Quarterly Journal. As regards growth during the first year (which had exceptionally dry periods) there are benefits from manuring of the order of 10 per cent. Interesting relationships were also shown between growth and rainfall. There appears to be good evidence that there is a critical size for the young plant (on this porous soil) below which it suffers a severe check from dry weather, but when it has passed this size the growth proceeds steadily.

In Block 17 several other experiments were laid out during the year. A second manuring experiment provides for results on seedlings and buddings, both clean weeded and under cover, to discover the optimum amounts and times of application for a complete chemical fertiliser. A cover crop experiment has been laid down on an elaborate plan for various covers under a large number of different methods of cultivation. The plan provides for tests in the open, under artificial shade and under rubber. The first planting of the covers in this experiment has so far been attended with only small success. This same block has experiments on natural covers (selective weeding) and on nursery beds (manuring and soil temperature and moisture).

The jungle reserve area was visited on two occasions with the Visiting Agent, Mr. D. S. Gardner. A large part of the area is flat and sandy, similar to that already opened up. The uniformity is considered to be valuable from the point of view of experiments.

Part of the area is hilly, with soil considerably heavier. The following analyses of five soil samples brought back from these visits show the nature of the area. Number 1 represents the flat, light soil and the others the heavier soil on the hills.

MECHANICAL ANALYSIS.

	No.	1	2	3	4	5
Sand	per cent	78.9	66.04	41.8	48.0	54.6
Silt	,, ,,	9.64	3.26	1.6	2.0	3.4
Clay ...	,, ,,	11.46	30.70	56.6	50.0	42.0
Loss on ignition	,, ,,	3.68	7.85	9.62	9.15	8.9

CHEMICAL ANALYSIS.

Carbon	per cent	0.840	2.292	1.158	1.308	1.542
Nitrogen	,, ,,	0.047	0.157	0.064	0.068	0.076
C/N ratio	,, ,,	17.9	14.6	18.0	19.2	20.1
Phosphate (PO_4)	,, ,,	0.238	0.943	1.754	1.370	1.389
Potassium (K)	,, ,,	0.013	0.026	0.013	0.022	0.013

Passing mention should be made of an experiment carried out to ascertain the soil temperatures attained during the burning off of felled jungle. The soil is a very poor conductor of heat, and the presence of moisture in it would preclude the attainment of temperatures above 100°C. Such considerations led us to believe that the fire does little harm to the soil, but it was thought worth while to test the matter. Immediately prior to a burn a recording thermograph was buried at 18 inches depth, while several melting-point pyrometers improvised in the laboratory were buried at less depths, using bismuth alloys and giving indications down to a temperature of 85°C. The results of the tests were that none of the alloys were melted, showing that the temperature of even the surface inch of soil did not rise above 85°C, while the thermograph record showed only a gradual rise of about 1°C. Thus the conclusion is borne out that a burn in ordinary circumstances has little direct effect on the soil beyond sterilisation of a superficial nature. Far-reaching changes do, of course, take place under the sites of stacked fires during clearing operations, when the application of the heat is so prolonged.

LECTURES.

Five lectures were delivered to gatherings of planters by the Head of Division, including one at the Annual Conference of the Incorporated Society of Planters at Ipoh. Dr. Flint gave one lecture to an audience of planters and also one to the Malayan Section of the Institute of Chemistry on "Micro-Methods of Chemical Analysis." The Division contributed two of the Staff Colloquia during the year, one on some recent work on soil capillarity (W.B.H.)

and one summarising to date the collected results from estate experiments on manuring (C.F.F.).

Publications.

The following articles were published during the year:—

(1) "Some Considerations on Silt-Pitting."
By W. B. Haines. Quarterly Journal, Vol. I, No. 1.

(2) Manuring of Rubber. I. General Considerations.
By W. B. Haines. Quarterly Journal, Vol. I, No. 1.

(3) "The Role of Humus in Tropical Soil Management."
By W. B. Haines. Quarterly Journal, Vol. I, No. 4.

(4) Block 6 Manuring Experiment, R.R.I. Experiment Station, 1st. Report.
By W. B. Haines. Quarterly Journal, Vol. I, No. 4.

(5) "Micro-Chemistry."
By C. F. Flint. Proceedings Malayan Section, Institute of Chemistry.

(6) "The Problem of Soil Analysis."
By C. F. Flint. Quarterly Journal, Vol. I, No. 3.

Special Trip.

During May the Head of Division spent some time in Java as delegate to the Fourth Pacific Science Congress and to the Conference of scientific workers connected with rubber production which was held at the same time. The three days of discussion and the visits which followed were found to be most stimulating. The problems on rubber estates as regards soil investigations were found to present much the same features as in Malaya. In regard to leguminous covers in old rubber, however, there seems to be no doubt that conditions in Java are in general much more suitable than those in Malaya. This may be attributed to the difference in soil types.

General.

The sand culture experiment mentioned in last year's Report was set aside for a time owing to staff changes. Towards the end of the year it was found possible for Dr. Flint to take this in hand and to make a fresh start with a number of budded stumps in pure sand culture. The aim of this work is to obtain observations on the symptoms (especially leaf discolouration) of particular deficiencies of plant food.

It is a pleasure to record considerable extension of co-operation during the year. This has been a feature both as regards internal relationships between Divisions and as regards our contacts with various Government Departments.

William B. Haines,
Head of Soils Division.

March, 1930.

ANNUAL REPORT 1929.

BOTANICAL DIVISION.

During the period under review the work of the Division has been steadily developed along three main lines.

The first of these, plant breeding and the parallel study of variation, is essentially long period work with a crop like rubber. Though no new results of immediate importance have come to light during the year much ground-work has been covered, which cannot be expected to bear fruit for some years.

The work on vegetative propagation is still in the stage in which comparatively rapid advances are possible and has been mainly directed towards the improvement of the technique of the budding operation and the subsequent planting of buddings.

Examination of the performance of mature budded trees and the development of a satisfactory tapping system has formed the third main section of the work of the Division.

Variation.

From time to time further measurements of leaves and seeds have been made on the lines indicated in the last report, especially for the record of the characters of parent trees from which seedlings have been planted on the Experiment Station. The chief immediate use of such measurements has again been in the identification of clones. Further collections have been made of leaves and seeds of the Pilmoor Estate clones to gain information as to the constancy of their characters from year to year. Possible changes with the age of the tree must be remembered in tracing buddings back to their mother trees.

In addition to the discovery of a few further rogues in the less important Pilmoor clones a considerable time was spent in sorting the Sungei Way Estate buddings (see below) into clones by tree and leaf shape and seed characters. Areas of buddings without planting records on three other estates were visited for the same purpose, but in all three, largely as a result of the experience on Sungei Way Estate of the labour involved in sorting the trees of a mixed area into clones, it was decided to wait until the tapping tests should show the presence of promising trees. Then if examination shows that the best trees fall into clones attention will be concentrated on those alone with a great saving of time.

Assistance was given also to another estate in the examination of seeds from buddings and their supposed mother trees.

With the rapid spread of budding and the consequent establishment of multiplication nurseries the identification of buddings in the first year of growth has become important. The typical leaf shape, storey shape, bark characters etc., all of which vary with local conditions, have been studied for a number of the best known clones in nurseries on several widely separated estates.

In continuance of the study of variation in the offspring of single trees pollinated naturally, seeds were obtained from trees with yield records on several estates. Five of the mother trees are on Pilmoor Estate in the field in which yield records of all the trees were kept for the Rubber Growers' Association Field Experiment No. 3 (Quarterly Journal **I.** 3. 1929). The immediate neighbours of some of the other mother trees also have now been included in the yield records in the hope of throwing light on the quality of the possible male parents of the seedlings. The seedlings from each tree have been planted out in separate groups, varying in size from about fifty to four hundred, in Block 16 on the Experiment Station as far as possible in uniform conditions.

The investigation of the latex vessel system of the embryo has been continued, but the slowness of the technique has not allowed any definite conclusions to be reached. A method has been devised for examining the embryo without damaging the seedling and specimens have been preserved for future examination.

Experiments have been made on the lines described by Ramaer of the Java Central Proefstation (de Bergcultures 1929 **3.** 50. p. 1267) for obtaining two plants from one seed. The young seedling is split in two without damaging the stalks of the cotyledons so that each half can still draw on the food reserves in the seed. The buds in the axils of the cotyledons grow out, and the two plants that develop are left undisturbed until each has expanded its first whorl of leaves and is capable of independent existence. They are then separated carefully and planted in baskets.

The twins thus obtained have been planted in Block 4 C of the Experiment Station and others are growing. Comparative observations of growth have been started.

Selection and Breeding of High Yielding Trees.

Numerous enquiries have been received on the subject of clone trial experiments and the establishment of plots for this purpose on estates. On many estates systematic yield records of promising trees have been taken over a number of years. On some of these estates buddings have already been established from the best trees.

At the present time many different clones established and tested in Malaya, Java, and Sumatra are available for commercial planting. Many of the clones appear to be of almost equal value from their published yield records but the choice of clones is complicated by the fact that the records available have been obtained under such widely different conditions that there is no reliable basis of comparison.

For the devlopment of new clones in Malaya a special block has been planned on the Experiment Station where buddings made from selected trees may be established along with buddings of well known tested clones for comparative study. A scheme for the further recording and selection of promising individual trees has been circulated to about 150 estates. Under this scheme the following records are being obtained:

1. On four tapping days, taken at approximately equal intervals during each month, the latex is coagulated in the cup for each selected tree. After being rolled (or creped) and dried the samples are carefully labelled and forwarded to the Institute for weighing and recording.
2. In addition to the actual samples the total weight of dry rubber obtained from the task in which each selected tree is growing, is also given for each month together with
3. the actual number of tapping days, and
4. the number of trees in the task.

From (1), the weights of the samples, the average yield per tapping of each selected tree is calculated.

From (2), (3) and (4) the mean yield per tapping of the average tree in the same task is obtained.

The value of the ratio between these two quantities $\frac{\text{Yield of Selected Tree}}{\text{Yield of Average Tree}}$ gives an indication of the superiority of the selected tree over the trees among which it is growing. The selection of prospective mother trees of new clones will not so much depend upon the actual yield as on the value of the ratio obtained from the above records.

In selecting promising trees for testing in the manner outlined, it is assumed that a careful inspection for disease and other defects such as poor bark renewal, has been carried out. Trees which appear to enjoy special advantages of position are also discarded. The aim is to select trees growing under perfectly normal conditions that show a productive capacity well above the average. The phenomenally high yielding tree is generally a source of disappointment in the long run.

The trees selected under this scheme will provide budwood for trial in work on the development of new clones. Where seed from these trees is available it will be used in the establishment of further families of seedlings for genetical study.

The only seed obtained this year from high yielding parents outside Malaya is a further supply by the kindness of the Anglo Dutch Plantations (Pamanoekan en Tjiasemlanden) Java from their Tjikadoe seed garden.

Experiments on pollination on the budded trees at Pilmoor Estate have been continued, and we would express again our indebtedness to the manager and acting manager for the facilities afforded.

Pollination was carried out during both the main flowering seasons and, as some flowers of various clones were found at other times as well, some pollinations were made in every week but one from March to November, when flowering definitely ended, in order to study seasonal effects. Observations of the condition of the flowers, the time of day, temperature and humidity, were made in continuance of the attempt to discover the most suitable conditions for pollination. Detailed results have not yet been worked out from the mass of data obtained.

The alternative methods of protecting the flowers from insect visitors after pollination by muslin bags or plugs of cotton wool were both used. The first examination of the results shows a superiority of the bagging method as measured by the initial set of fruit three or four weeks after pollination.

Female flowers belonging to ten of the Pilmoor clones were pollinated by hand, and nine of these clones with Lunderston Estate clone N in addition were used as male parents. As some unripe fruits are still unpicked, final figures will be given later, but the following table gives a fairly good idea of this year's success.

	Flowers.	Fruit.	Percentage of success.
Crosses ...	4,045	305	7.5
Selfs ...	439	8	1.8
Total ...	4,484	313	6.8

It is interesting to notice that, although in 1928 every self pollination failed, yet in 1929, 252 flowers of Pilmoor clone A44 gave 7 fruits (2 are not yet ripe, though full sized), and in D61 one fruit is growing from 70 flowers, but 117 pollinations within B16 all failed.

During the second season it was intended to obtain large groups of seed from one or two crosses that had given good success before, but enough flowers were not always available at the same time. It is hoped however that a few families of 50 to 100 or more seedlings will be raised.

By the kindness of the manager arrangements were made to carry out pollination on the Lunderston Estate clones, but in September the flowering was poor and many inflorescences shed their flower buds before they opened. One fruit is growing from 25 flowers of Lunderston clone N crossed with clone K and from the reciprocal cross one fruit has grown from 50 flowers. Pollination of Pilmoor A44 with Lunderston N was more successful and 43 flowers gave 6 fruits. The latter are included in the summary for Pilmoor Estate.

As the fruits ripen the seeds are planted in the nurseries at the Institute. Later the seedlings are transferred as basket plants to the area reserved in Block 16 at the Experiment Station, and planted in groups with ordinary seedlings from the same clones as controls. Buddings of two or three of the clones have been made for interplanting and nearby seedlings from other sources will also give a basis for comparison.

Vegetative Propagation.

A. Laboratory Investigations.

(1) *Union of stock and scion.* The detailed study of the process of union of scion and stock in the growth of a normal budding has been continued and further important points have been established.

The most interesting new fact which has been noted concerns the regeneration of the cambium in the bud patch and the connection of the regenerated cambium with that of the seedling stock.

Normally, in the region of the union of the bud patch and the exposed surface of the wood of the stock, once the first linkage has taken place the new cambium is formed entirely from the tissues of the patch and becomes united to the cambium of the stock only around the edges of the bud patch.

A number of exceptions have been observed in which the cambium between the bud patch and the stock is regenerated equally from cells derived from both scion and stock.

The significance of these observations must await further study but it seems possible that the double origin of the cambium zone which connects the bud to the stock may have a positive influence on the yield of the resulting tree. In an attempt to discover the conditions which determine the more intimate union of scion and stock buddings have been made on stocks grown from seeds of the same clone from which budwood is derived.

(2) *Relation of the latex vessel systems of scion and stock.* Bark samples have been taken from budded trees at present undergoing tapping tests on Pilmoor Estate. Samples were taken at different levels; immediately below the union, immediately above the union, at 20 inches and at 40 inches from the union. These samples are being investigated from the point of view of the relationship between the latex vessel system of the stock and the scion.

(3) *Examination of Budwood.* During the first few weeks of the general budding season—September and October, numerous samples of defective budwood were received at the Institute for examination. Most of the complaints were the same, namely, that it was generally impossible to "strip" the bud patch from the wood. The samples received were examined in comparison with normal satisfactory budwood. In almost every sample the condition of the refractory material was the same. The cambium cells were in a resting condition and the zone of active tissue, which in the normal vigorous budwood is seldom less than eight cells deep, was generally reduced to a narrow zone not more than three cells deep. This condition is characteristic of slow growing lateral branches on older trees and there is no doubt that many of the samples of budwood sent in for examination had been obtained from such branches. It is therefore important to stipulate in purchasing budwood that the material be taken from multiplication nurseries or at least from very young budded trees, which are in vigorous growth at the time the budwood is cut. After leaf fall, whether this results from normal wintering or is induced by drought conditions or by disease, the cambium tissues become temporarily inactive and the use of budwood cut from plants in this condition is impracticable.

(4) *Wound tissues in Hevea.* The formation of wound tissues in the stem of Hevea is being investigated. The question is of importance both in work on budding and in its later stages in relation to tapping. Up to the present this work has been chiefly concerned with the later stages of the budding operation itself and the operations that immediately follow the successful union of a bud patch with the seedling stock.

The changes that take place in a stem in the region of a pruning cut have been studied in view of their importance in transplanting operations.

It is found that when the stem of a young rubber plant is severed without disturbing the root system of the plant complete sealing up of the severed wood vessels (and latex vessels) takes place in from 4 to 7 days. The living cells just below the cut surface become very active and produce a specialised form of wound gum which fills the ends of the larger water conducting vessels and prevents further loss of water.

If the root system is disturbed at the same time that the stem is severed, water is drawn from the open vessels faster than it can be replenished by the damaged root system. The living cells near the wound are therefore dried out before they have had a chance to manufacture the necessary sealing fluid. As a result the stem dies back. Under drought conditions or in exposed situations, the extent of the drying out which takes place in this way is frequently sufficient to cause the death of the plant.

In planting budded "stumps" the object should be to utilize the whole of the energy of the plant in making a vigorous shoot from the grafted bud. Generally the bud nearest to the sealed pruning cut is the first to grow out and to avoid troublesome pruning of the shoots which appear from the stock above the point of budding it is clear that to give the grafted bud the best chance the pruning cut should be made below the lowest dormant buds on the seedling stem. In practice this is generally found to be 6 inches above the collar of the seedling stock. If pruning is to be carried out at this level the risk of drying out must be guarded against or heavy losses will occur in transplanting. By pruning plants budded in the nursery at this height and allowing them to remain undisturbed for about one week before transplanting the normal sealing of the wound takes place. After transplanting, the first bud to shoot is generally the grafted bud. A high degree of success has been obtained in transplanting budded stumps following this method.

The chief disadvantage of the method lies in the delay between pruning the stock and transplanting. The planting conditions at the time of pruning may be favourable. After a delay of a week, conditions may have changed entirely so that transplanting is not advisable. If these unfavourable conditions continue for some time the pruned buddings will begin to sprout in the nursery and can only be transplanted with considerable risk and difficulty.

Tests have been commenced with various preparations designed to replace the natural sealing substances produced at the pruning cut in order to overcome this disadvantage. The budded plants are pruned as described above and the pruning cuts are treated with one or other of the preparations under test. Pruning and transplanting are carried out on the same day.

B. Field Experiments.

Visits have been paid during the year to the various estates, mentioned in the Annual Report for 1928, on which field trials of buddings of a number of clones have been started.

Growth measurements and notes on the general characters shown by the same clones under different estate conditions have been made.

In addition to the small scale experiments laid down in 1928 by the Botanical Division, valuable information has also been gained from estates which received advice and assistance from the Institute in connection with more extensive budded areas.

During 1929 it has been possible to carry out the main programme of field work on the Experiment Station, Sungei Buloh. The details of this work are given in a later section of this report.

C. Advisory Work.

The volume of advisory work in relation to budding has shown a very large increase during the year. Written enquiries from over 200 estates have been dealt with and special visits have been paid to 58 estates in connection with these enquiries. These numbers only relate to special cases dealt with by the research staff and do not include the general enquiries and visits dealt with in the ordinary routine and field experimental work.

The scheme for training small gangs of coolies on estates was continued. Conductors were lent to 39 estates during the year. Owing to the increase in the field work in progress on the Experiment Station it was found necessary to curtail the loan of conductors during the later months of the year. Conductors from outside estates were given instruction on the Experiment Station during the progress of our own budding work.

Demonstrations in the technique of budding have been given at the Institute to a large number of visiting Managers and Assistant Managers. Whenever possible these demonstrations have been followed by visits to the Experiment Station to see the field work in progress.

D. Tapping experiments on Budded trees

1. Pilmoor Estate.—The first period of test tapping concluded in December 1928 was followed by three months' rest. During March 1929 a fresh census of the trees was made and girth measurements were taken. Tapping was recommenced on April 2nd on the following plan.

(1) All trees having a girth of 14 inches or more at a height of 40 inches from the union were marked out for tapping.

(2) Where the number of tappable trees in a clone exceeded 30 they were divided into two groups and tapped as follows:—

Group A. Tapped alternate daily.
Group B. Tapped daily in alternate months.

In both groups the tapping cut was a left-to-right spiral cut over half the circumference commencing at 40 inches from the union. Where the trees had been previously tapped the new panel was opened on the opposite side of the tree. The slope of the tapping cut was increased to 35°.

(3) Where less than 30 trees of a clone were available, all were tapped on the alternate day system.

(4) Alternate daily tapping commenced in April, daily tapping in the alternate months commenced in May. In all 589 trees were tapped as follows:—

Group A. 380 trees of 21 clones.
Group B. 209 trees of 8 clones.

The trees were divided into two tasks which contained as nearly as possible an equal number of trees of each clone. The tappers were regularly interchanged and the sequence of tapping was reversed daily in order to even up differences due to the individual skill of the tapper and time of tapping. The method of recording was the same as that previously used, the latex was coagulated in the cup for each tree and the samples from each tree collected at approximately weekly intervals, creped, dried and weighed.

In the table given below the yields recorded for the most promising clones are given in grammes of dry rubber per tree per tapping from April to December 1929.

Clone	Group A. Tapped alternate daily		Group B. Tapped daily in alternate months.	
	No. of trees.	Gms. per tapping.	No. of trees.	Gms. per tapping.
A 44 ...	52	17.0	51	15.6
B 84 ...	18	14.7	19	19.6
B 58 ...	32	11.8	31	13.7
B 16 ...	25	15.7	25	14.5
D 61 ...	17	14.5	...	...
D 65 ...	5	12.9	...	...

The difference in the yield of a particular clone under the two different tapping systems is very marked. Particularly is this shown in the case of Clone B 84. The work on this subject is being continued.

2. Sungei Way Estate.—A block of approximately 5 acres was budded in the field during December 1924 and January 1925. The mother trees from which budwood was obtained for this work were those selected by Sanderson and Sutcliffe on the basis of the records obtained in Field Experiment No. 2 (Quarterly Journal I, 3: 151-200). Budwood from other mother trees in the high yielding area reserved for selected seed was also used. Originally, alternate trees were budded and buddings derived from different mother trees are scattered throughout the field.

Since this field is typical of many of the early areas established with buddings of untested (unproved) clones and seedlings an at-

tempt has been made to identify the clones during the progress of the work with little reference to the original records.

After preliminary measurements of tree girth and bark thickness had been made tapping was commenced in April 1929. The details of the tapping system and the method of recording are the same as in the Pilmoor Estate Experiments described above.

Half of the trees (alternate rows), both buddings and seedlings, were tapped on alternate days and the other half tapped daily in alternate months. At the conclusion of the tapping period decided upon—April 1929, to February 1930—the tapping results will be carefully analysed to supplement the observations made on the trees in the work of identification of the best clones.

Experiment Station.

The main work of the Division has been (a) the establishment of experimental blocks with seedlings of known origin, resulting from controlled crossing work, and seedlings of pedigree material from various sources, (b) the development of work on budding and the establishment of trial plots and collections of material of tested clones from Malaya, Java and Sumatra.

In October training of coolies in budding work was commenced. Tamils, Malays and Chinese were taught but, owing to the urgency of work in hand and the more lengthy period required for satisfactory training of Tamils, the bulk of the budding programme was carried out by Chinese and Malays. Part of the later pruning work and all the transplanting of buddings was done by Tamils.

Block 2. The collection has been increased by 1929 seedlings from Java as already mentioned. Measurements of height have been made.

Block 4 A. 201 seedlings from the 1928 Pilmoor crosses were planted out, together with ordinary seedlings from the same clones and from estate "selected" seed.

Block 4 B. The nursery established in 1928 and early 1929 (5 acres) provided seedling stocks for the greater part of the budding programme. In all 370 metres of budwood from 20 tested clones were used. The average number of successful buddings per metre of budwood was 15.7.

The budded plants have been used as follows:

(1) For the establishment of a clone trial block (Block 5). Transplanted.

(2) For the establishment of multiplication nurseries in situ to provide budwood for future extensions and experimental work.

(3) For the planting of a special nursery for experimental work on the early characters of high yielding plants. The aim of this work is to study the characters of known high yielding plants in the early

stages of growth with a view to the possible selection of further promising material at a very early age.

Block 4 C. Half of this 5 acre block is devoted to a comparison of the growth of different types of planting material. Seed at stake and germinated seed—divided into two lots according to the rate of germination—were planted out in December, 1928. Other seedlings of the same batch were left in the nursery and transplanted in December 1929 as stumps—some on the day of cutting back and others left until the buds showed signs of growth.

The remaining 2½ acres are allotted to the 'twin' seedlings described above. The first of these were planted out towards the end of the year and others are nearly ready. Periodical measurements of growth were started.

Block 5. This Block of 40 acres has been established as a clone trial plot with buddings of 9 clones with the object of comparing their performance under uniform conditions.

The planting distance is 20 ft. × 20 ft. and the area is divided into 36 plots each of 121 plants. The plots are randomised so that each clone occurs once in each quarter of the block. The total number of plants of each clone is 484. The planting material consists of budded stumps prepared in the nursery in Block 4 and in the general nurseries in other blocks of the Experiment Station. The stocks were therefore of mixed origin, comparable with those which might be used on an estate, and the only stock selection practised was in budding the most vigorous stocks in each nursery bed.

Planting was commenced on November 21st and completed on November 29th. To avoid confusion budded stumps of each clone were planted in succession and as far as possible the planting of each clone was completed in one day. The following clones are included in the block:

A.	Clone	A.V.R.O.S.	152	Sumatra.
B.	,,	,,	49	,,
C.	,,	Prang Besar	23	Malaya.
D.	,,	,,	186	,,
E.	,,	Bodjong Datar	5	Java.
F.	,,	Tjirandji	1	,,
G.	,,	Pilmoor	A44	Malaya.
H.	,,	,,	B84	,,
J.	,,	A.V.R.O.S.	50	Sumatra.

The inclusion of the Pilmoor clones was made, not so much from the point of view of their value as high yielding clones for this is insufficiently known at present, but to maintain continuity of the ex-

perimental work which has been carried out with these clones, during the past two years. The rest of the clones were chosen as representing the class of material which has been most widely used in commercial plantings so far and appears likely to be employed during the next few years.

Block 15. This block is being planted with basket plants and seed at stake. Budding will be carried out in the field in 1930 and 1931 with material from selected mother trees growing in Malaya. Buddings of well known clones will be included for comparison.

Block 16. Part of this block is being planted with the groups of individual mother tree seedlings and the rest is reserved for the 1929 crossed seedlings with buddings and other seedlings from the same clones. All seeds were germinated in the Institute nurseries. Transplanting as basket plants was started in October.

Block 18. This block has been planted with stumps for budding in the field in 1930. The lay-out of this block will be designed for work on tapping of budded trees.

Germination and Vitality of Seeds.

The experiments mentioned in the previous Annual Report on factors influencing the vitality of Hevea seeds were continued. It was decided to work as far as possible on hand picked seed of known origin, and the Pilmoor and Sungei Way clones were chosen as the most convenient source. Unfortunately seed was not as plentiful as had been expected and the plans had to be modified considerably. Consequently although the results have given some fairly clear indications it is considered desirable to wait for confirmation with larger batches of seed.

Cover Plants.

During the year twenty three specimens of cover plants and naturally occurring weeds were received for identification and advice. Several specimens consisting of leaves only were inadequate for identification. The herbarium collection has been extended.

At the end of January experimental strips of *Desmodium heterophyllum* and of *D. triflorum* were planted at the Experiment Station in Block 4C. Grown at first from wild plants in nursery beds at the Institute the plants were shifted in turves, cut into pieces about four inches square, and planted in rows two and four feet apart. In spite of the rather dry weather that followed both species established themselves well and in comparatively few months the new shoots spread to form a continuous cover. As the rubber seedlings in the area were only a month or two old it remains to be seen how these species will behave as the rubber grows.

Publications and Lectures.

During the year the following ten papers were published in the Quarterly Journal of the Institute:—

Field Observations and Experiments on the Pollination of *Hevea Brasiliensis*. L. E. Morris. Vol. **I**, Nos. 1 and 2.

Experiments on the Pollination of *Hevea Brasiliensis*. L. E. Morris. Vol. **I**, No. 3.

Budding in the Field. C. E. T. Mann. Vol. **I**, Nos. 1 and 2.

A Short Review of the Present Position of the Planting of Buddings of Proved Clones. C. E. T. Mann. Vol. **I**, No. 4.

A Brief Summary of Budding Procedure. C. E. T. Mann. Vol. **I**, No. 4.

A Note on Preparation of Nurseries for Budding Work. C. E. T. Mann. Vol. **I**, No. 4.

Care of Multiplication Nurseries. C. E. T. Mann. Vol. **I**, No. 4.

A Note on Clone Trial Plots. C. E. T. Mann. Vol. **I**, No. 4.

Notes on a Test of Methods of Packing Budwood. F. Billington. Vol. **I**, Nos. 1 and 2.

Observations on Bark Thickness and Renewal in Malayan Buddings. F. Billington. Vol. **I**, No. 3.

Lectures were given by:—

The Head of Division on "The Early Diagnosis of High Yielding Rubber Plants" to the Malay Peninsula Agricultural Association at Nebong Tebal, and on "Budding" to the Kuantan Planters' Association.

Mr. L. E. Morris on "Plant Breeding" to the District Planters' Associations at Rengam (Johore) and Malacca, and to the Local Branch of the Incorporated Society of Planters at Taiping.

Exhibits on budding, supervised by Mr. F. Billington, were made at the Shows of the Agri-Horticultural Associations at Taiping, Ulu Langat (at Telok Datoh) and West Pahang (at Karak).

General.

In May the Head of the Division visited Java as a delegate to the Rubber Conference and the Fourth Pacific Science Congress.

The Head of the Division left the Institute on October 3rd. The responsibilities of the Division have since been shared by the Geneticist and Plant Physiologist.

It is a pleasure to record our thanks to the managers and assistants on the many estates where experiments and observations have been carried out.

The thanks of the research staff are due to the members of the subordinate staff for their assistance in the labour of making numerous observations and measurements for future use.

L. E. Morris,
Geneticist.

March, 1930.

C. E. T. Mann,
Plant Physiologist.

ANNUAL REPORT 1929.

PATHOLOGICAL DIVISION.

Staff.

Dr. Weir, Head of the Division left the service of the Institute to become Director of the Research Laboratories of the Goodyear Rubber Plantations in Sumatra on July 18th, so that for the greater part of the period under review, the division was considerably understaffed and work has been more than a little hampered.

Mr. Sutcliffe proceeded on leave on January 10th and returned to duty on October 10th.

Dr. Rhodes was appointed to the Division in January and carried out important biochemical investigations on Brown Bast tissue. About the end of July, he was transferred to the Chemical Division.

Field Investigations.

The first part of an important piece of practical work on investigation of root disease was completed during the year and a report was drawn up.

In October a second field observation experiment on a much larger scale was started and is now being continued. A certain amount of field work has been carried out on the Experiment Station, Sungei Buloh, including the budding of 10 months' old plants with buds from known high yielding Brown Bast trees. This experiment should go far to settle definitely whether the predisposition to develop Brown Bast is present in the vegetative offspring of Brown Bast mother trees. At a later stage it is intended to test the control of Brown Bast on these trees by various tapping methods especially as regards tapping frequency and length of cut. Certain soil fungicides are in progress of testing for control of root disease fungi, more especially of *Fomes lignosus*.

Fungicides.

A very large number of fungicides, patent disinfectant preparations, crude distillates, residual products etc. have been tested by standard methods, and detailed records made in respect of penetration etc. when applied to Hevea cortex. Mr. Sutcliffe hopes to prepare the records for publication during 1930. A good deal of work has been carried out in investigating and testing various mixtures mostly with an Asphaltum base for use in treating pruned surfaces, including the pruned ends of budded plants. Some of these mixtures are very pro-

mising and, if definitely proved efficient, will be very economical. A considerable number of spraying mixtures etc. have been tested on a small scale to determine the effect on young foliage. A full account of this work will be published later.

Leaf Diseases.

Secondary Leaf Fall due to Oidium Heveae.

This leaf disease which has now spread throughout the Eastern rubber growing areas became more pronounced in certain districts during the past year and appeared in districts hitherto exempt from attack. Cases were reported from the coastal districts of Perak, Selangor, Negri Sembilan and Malacca. In those areas where abnormally dry weather was experienced during the wintering season the continued activity of the fungus caused several successive defoliations. Fortunately this was not general. There is a general indication that successive years will probably show an increase in intensity of attack accompanied by an increase in areas affected and, if so, the installing of power sprayers and/or power dusters will become a necessity. The investigations already carried out by Mr. Beeley, suggest so far that dry conditions are essential to the successful attack and development of the fungus on Hevea leaves and flowers. No resting spore stage has so far been observed.

In general, apart from Oidium, no cases of leaf disease on an extensive scale were reported. The association of mites with certain leaf diseases was again noted on several occasions.

Abnormal Leaf-fall of Budded Plants.

In the early part of the year Mr. Beeley isolated a species of Phytophthora from material received. Inoculation experiments will be carried out later. A similar species has been demonstrated to cause "Dieback" of buddings in Ceylon.

Diseases of the Tapping Panel.

Mouldy Rot of the Tapped Cortex due to Sphaeronema fimbriatium.

This disease of the tapping panel has been reported from all parts of the Peninsula during the past year and once from an entirely new district. As a bark disease it would appear to have come to stay but the damage done under present conditions is comparatively small, although financial losses owing to loss of crop may be considerable. Usually control is quickly established and serious outbreaks are not common. The position would be much improved if a more

efficient control on small holdings could be established. The disease can no longer be considered as a purely wet season effect since cases have been reported during comparatively dry periods. The recent publication on diseases of the tapping panel in the Quarterly Journal Vol. I., No. 4 should help considerably in diagnosis, and the treatment outlined has been found to be quite effective when properly carried out.

Black Thread or Black Stripe due to Phytophthora sp.

There has been a considerable increase over 1928 in the number of estates from which Black Stripe has been reported. It would appear from the distribution also that the disease has shown signs of increase both in number of affected estates and districts. In some cases the disease was of a particularly virulent type and it is possible that either more than one strain or more than one species of Phytophthora is involved. Continuous preventive painting or spraying may become necessary in certain districts except perhaps during dry periods. As a bark disease it is second in importance only to Mouldy Rot, and, unless carefully controlled, may cause great loss.

Brown Bast.

Dr. Rhodes, Biochemist, was attached to the Pathological Division for about seven months during which period he carried out investigations of Brown Bast tissue. Some interesting results were obtained especially as to the possible part played by the "wound gum" in Brown Bast tissue, its origin, and chemical characteristics. A full account of the work will appear in the Quarterly Journal Vol. 2, No. 1, 1930. The question of dealing with Brown Bast in old rubber—over 15 years old—has again recurred several times. Old cases in which whole panels or even larger areas are affected require special consideration. The isolation treatment, apart from its use in preventing the further spread, presents considerable difficulties and further experimental work on various combinations for such cases is urgently necessary. The general position as regards Brown Bast remains much as in 1928 except that increases have been noted. In general, estates have been advised to test the isolation method in younger areas more especially where as yet only a comparatively small area of cortex is involved. It should always be remembered that such isolated small bark areas must be tapped off in the ordinary course of tapping. In almost all cases, deep scraping without the application of a protective and repellant cover or paint is dangerous, since such exposed cortex is very liable to attack by boring beetles. Interesting and important data is steadily accumulating concerning the correlation of Brown Bast and very high yields.

Patch Canker or Claret Coloured Canker due to Phytophthora sp.

The appearance of this disease, sometimes confused with Brown Bast has been very irregular and the cases noted have been comparatively few. It is almost certain to recur in certain districts and will necessitate constant and careful attention to keep it reasonably well under control, especially during the wetter periods. There has been no evidence of the spread of the disease to any considerable extent. It is significant that in areas on which this disease recurs, Black Stripe is or has been prevalent.

Internal Fissures.

Mr. Sutcliffe has completed investigations of a new disease of the rubber tree in Malaya. Two types have been found, one of which appears to be identical with that described by Bobilioff in Java. The disease is characterised by the presence of internal fissures in the cortex extending along the lines of the latex vessel systems. The positions of these fissures are revealed only during tapping. A complete account of this work will appear in the Quarterly Journal Vol. 2, No. 1, 1930.

Root Diseases.

Fomes lignosus.

This is perhaps the best known and the commonest cause of root disease especially in rubber under five years old, though it has been noted during the year in rubber of all age classes. A considerable amount of data has been collected regarding the incidence and intensity of this disease in young clearings, more particularly in its relation to cover plants. The rapid development of the fungus on cover plants and on timber more or less covered with the cover plants has been repeatedly noted. This position raises a most difficult problem regarding the use of covers in new clearings and every case must be dealt with on its merits. Under certain conditions the question of retention or otherwise of the cover requires careful consideration. Various methods of treating Fomes areas are being tried, especially the use of soil fungicides of which the toxicity to the fungus has been proved in cultures.

Fomes pseudoferreus.

This fungus must be considered the most serious menace to mature rubber areas. Investigations carried out during the year have demonstrated quite clearly that spread is almost invariably by root contact. The dangerous practice of sometimes isolating a diseased tree and leaving the laterals *in situ* outside the isolation

trench has been proved. Two cases of attacks in rubber under seven years old were noted. This is unusually early for the disease to become definitely manifest. Towards the end of the year investigations were started on a large scale to determine the incidence of this disease in rubber of different age classes and to test various control methods and treatment. It is intended to continue the work during the present year from about April onwards. The present condition of many old rubber areas due to the destructive agency of this fungus is causing grave concern. The large gaps in some areas require special treatment. The effect of grass or other covers on such sites has been the subject of investigation.

Ustulina zonata.

The presence of this fungus as a root disease has been repeatedly noted more especially in old rubber. On some estates it is even more common as a stem and branch disease, where it gains entry by way of a "hat peg" or by a pruned surface. Careful treatment after pruning would certainly prevent the great majority of stem and branch attacks. Outbreaks on a somewhat extensive scale have been noted in mature areas subjected to severe flooding in previous years. Where heavy silting also occurred the effect was usually intensified.

Branch and Stem Diseases.

Pink Disease—Corticium salmonicolor.

This branch and stem disease has apparently not been nearly so prevalent as during 1927 and 1928. The treatment of young immature areas—under five years old—requires great care if damage by the fungicide is to be prevented. The use of crude oil or a mixture of crude oil with other ingredients is apt to be dangerous, in spite of the fact that such mixtures have answered well in some cases.

"Die-Back."

This very general term applied to immature rubber includes attack by *Gloeosporium Phyllosticta* and *Colletotrichum* usually followed by "Diplodia." Many cases were reported and in a few instances considerable areas were affected. It was found to be much more prevalent in poorly grown rubber, especially during dry weather and suggests a relationship with soil conditions.

Insect and Other Pests.

Varying degrees of damages to both immature and mature rubber have been noted due to one or more of the following insects:—Grasshoppers, Beetles, Caterpillars, Scale insects.

Grasshoppers.

A considerable number of cases of the young shoots on bud-grafts being damaged by grasshoppers has been noted. Such cases have appeared both in the presence and absence of cover-plants, in the field and in the nurseries. The use of poisoned baits etc. has been advocated, but usually hand collecting by children is effective and may sometimes be combined advantageously with spraying.

Beetles.

Cases of nursery plants being attacked just below the collar by beetle larvae have occurred. In almost all cases these proved to be Cockchafer larvae, which are essentially root feeders.

Caterpillars.

Various caterpillars have been noted on occasion to attack the tapped cortex, but usually the pest has not been serious and normally is easily controlled or checked by application of a dilute disinfectant. The most widely distributed of these and the one which usually occurs in largest numbers is the "Basket Worm" or "Bag Worm" the the larva of a *Psychid* moth—*Acanthopsyche snelleni.*

Scale Insects.

Several cases of damage by *Lecanium* sp. and by *Pulvinaria* sp. were reported during the year. Most of these referred to nursery plants or to young plants in clearings. Some cover plants were found to encourage these pests.

Mites.

There is evidence that mite damage is increasing. This may be due to weather conditions in part but assumes a somewhat serious aspect in connection with various leaf diseases e.g. *Helminthosporium Heveae* and *Oidium.* The use of sulphur or sulphur compounds either as dust or spray is indicated as a control measure.

Snails.

A few cases of damage to young shoots by small snails were noted, but such damage was not extensive and control was quickly established.

Rats and Squirrels.

Rat damage was reported from a few districts mostly on young clearings, the nurseries being exempt from attack except in a minority

of cases. Various methods of control have been tried. Reports have been received of squirrels attacking the renewing cortex and also damaging young stems by gnawing the bark.

Miscellaneous.

Windfall.

Only one case of windfall on an extensive scale has been noted or reported during the year under review. This state of things is probably closely connected with absence of flood conditions which had disastrous results in the early part of 1927 and, to a much smaller extent, in 1928.

Floods.

There have been no records of flooding on a large scale noted during the year comparable to the floods of 1926—1927. The after-effects of the 1927 floods have become more evident, resulting especially in an increase of root diseases. In some cases the full effects of silt deposits are now evident over considerable areas. The abnormal development of epiphytes especially mosses and liverworts on rubber trees in silted areas has been noted. Such growths have been coincident with marked "dieback" appearance due primarily to gradual root asphyxiation.

Replanting.

This question has assumed a greater importance during the past year. The problem of old rubber areas, which year by year are proved to be a more or less steadily declining asset to the companies concerned, considered in conjunction with the probable high yielding areas (budgrafts or selected seed) of the immediate future assumes a more pronounced importance each year. The pathology of such areas has been investigated on several occasions. No general procedure can be laid down since it is essential that each case should be separately considered. In this connection a detailed history of the areas concerned is of the greatest value as a guide to procedure.

Advisory Work

During the year 50 visits were paid to estates and 500 answers to enquiries sent out. Details of these are as under:—

Subject.		*Number of replies to enquiries.*
Abnormal growths	...	3
Injury by external agent	...	87

Fungus diseases of rubber	...	240
Brown Bast	...	36
Diseases and Pests control	...	1
Epiphytes on rubber trees	...	1
Fungicides	...	37
Tree operations	...	16
"Dieback" in old rubber	...	9
Cover plants	...	7
Replanting	...	15
Resistance and Immunity	...	2
Seed-bed and Nursery diseases	...	4
Spraying and spraying equipment	...	10
Budgraft diseases	...	3
Miscellaneous	...	30
		501

PUBLICATIONS

During the year the following publications have appeared from the Division:—

1. Vegetative Characters and Yield of Hevea. By A. R. Sanderson and H. Sutcliffe. Quarterly Journal Vol. I. Nos. 1 & 2.
2. Vegetative Characters and Yield of Hevea. By A. R. Sanderson and H. Sutcliffe. Quarterly Journal Vol. I. No. 3.
3. Fungi and Diseases of the Tapping Panel. By F. Beeley. Quarterly Journal, Vol. I. No. 4.

Dr. Weir attended the Fourth Pacific Science Congress and Rubber Conference in Java, representing the Pathological Division.

GENERAL.

No particular disease or pest has been noted or reported during the year as of outstanding importance and the position in general remains much as in the previous year. The claims on the Institute for advisory work have increased considerably during the year. This must be considered a healthy sign, as it indicates an increasing interest being taken by planters generally in the activities of the Institute. The organisation of a field staff will eventually relieve the Division of much of the advisory work and so leave more time for research and field experiments.

A. R. SANDERSON,
Acting Head of Pathological Division

March 1930.

ANNUAL REPORT 1929.

CHEMICAL DIVISION.

Introduction.

For the purpose of presenting a review of the activities of the Chemical Division for the year 1929 it is desirable to describe the work under three headings; Internal, External, and Advisory, and in order that the Annual Report may furnish an informative record of this Division of the Institute, it is necessary to refer to the conditions and general facilities available during the year.

Staff.

For the majority of the period the staff consisted of two European officers, one Indian graduate and two Asiatic laboratory assistants.

Major B. J. Eaton returned from long leave and resumed duty on the 24th January. He was absent for approximately two months out of the first half year and from August onwards was appointed to act as Director of the Institute.

Dr. Rhodes was transferred from the Botanical staff and became available for chemical research towards the end of July, and in October an additional appointment was made when Mr. R. O. Bishop assumed duty as acting Head of the Division.

The position at the close of the year was, therefore, much more satisfactory as regards qualified officers, but in respect of other staff there are many obvious deficiencies; and the lack of an experienced subordinate staff continues to be a handicap in the work of the Division.

Internal Work.

This embraces three classes of investigations; those arranged in accordance with the research programme, those investigations arising naturally out of the enquiries received from external sources, and those investigations that are planned to improve and extend the laboratory methods available for use in the Division.

In practice the two latter are closely related and the continuous elaboration and perfecting of suitable laboratory methods is an essential feature where numerous and varied demands for practical assistance are to be dealt with expeditiously and efficiently.

The freedom to engage in work beyond the limits set by the nature and magnitude of the immediate demands for practical assistance

depends very largely upon the strength of the staff, and the activity of those to whom the Division is accessible.

During the period under review the immediate accessibility of the Division to the planter—probably exceptional in a research institute—has given rise to a volume of demands sufficient to exclude many of the investigations falling within our prearranged programme of research. From the early part of the year the European staff, when not engaged entirely on advisory work, was sufficient only to deal with the immediate executive work of a laboratory staffed by subordinates of limited experience and capabilities. It became possible, however, towards the close of the year to devote some attention to the general scheme of work outlined in the research programme, and the following is to be recorded.

Separation and Characterisation of Latex Constituents.

It is no exaggeration to say that at the present time the state of our knowledge of Hevea latex and its constituents remains in much the same position as it was fifteen to twenty years ago. Since the time when Eaton and his colleagues and Whitby and De Vries investigated the importance of some of the nitrogenous substances occurring naturally in latex the volume of results on the chemistry of latex has been relatively small, and compared with the rapid advancement that has taken place in some branches of rubber technology it is worthy of note to find the chemistry of *fresh* latex such an unexplored field. The fundamental difficulties inherent to pure chemical research on fresh latex are easy to appreciate, but the results to be obtained appear to be so important to a proper understanding of the physical and chemical characteristics of rubber and factors associated with the preparation of plantation rubber that there is a real and pressing need for the Chemical Division of the Rubber Research Institute to devote considerable attention to research of this nature.

For these reasons it was seen fit, as soon as the exigencies of staff permitted, to arrange for one European officer to devote himself to latex investigations, and Dr. Rhodes has been engaged on this work since October. Up to the present attention has been focussed particularly on the so-called "carbohydrate" in fresh latex. Preparation in a pure state of adequate quantities has been accomplished and a study of its characteristics can now be proceeded with.

The fatty constituents in latex previously investigated by Whitby. have also received some attention. The separation of these constituents of fresh latex is being continued in accordance with the experience previously gained in the Department of Agriculture and the preparation of a suitable quantity for examination is in hand.

The Physico-Chemical Properties of Latex.

The utility of a study of the physico-chemical properties of Hevea latex lies not only in its application to the preparation of rubber for export in the commercial forms now the fashion for plantation products, but also to the export of preserved latex and particularly to the removal of water from latex and its preparation and use in a concentrated or even desiccated form. Such work is necessarily of a fundamental nature and covers a wide field of investigation.

In this connection during the past year some attention was paid to a study of coagulation phenomena and a definition of the boundaries of the zones of complete dispersion, flocculation, and coagulation in terms of hydrogen ion concentration. Determinations of the hydrogen ion (pH) values of latex and serum were made and a technique was developed for electrometric measurements by means of the quinhydrone electrode. The work of Van Harpen was confirmed and further information was obtained regarding the influence that variations in the dry rubber content have on the pH values defining the transition points between the different zones, and on the degree of dispersion within the second liquid zone. The effect of the addition of ammonia and of various soaps was also investigated.

Other Problems.

Other investigations more nearly related to the immediate demands of the industry have been carried out on the following subjects:—

1. Mould development on sheet and crepe.
2. Bubble formation in sheet.
3. The preparation of wide sheet.
4. The drying of sheet.
5. The use and relative value of fungicides in sheet manufacture.
6. The plasticity of raw rubber.
7. The dry rubber content of preserved latex.
8. Criteria for evaluating the quality of raw rubber.

The results achieved in some of these investigations have been recorded in the Quarterly Journal or in separate publications which are enumerated at the close of this report. With regard to the others, the following results are worthy of record here.

Bubbles in Sheet Rubber.

On some estates it was stated that the addition of para-nitrophenol to latex as a preventive measure against mould growth favoured the formation of bubbles in the prepared sheet and, further to the investigation of this contention, experiments were carried out to

obtain more information on the cause of bubbles in smoked sheet. It was found that the addition to the latex of para-nitrophenol alone, or in conjunction with sodium sulphite or formalin, according to the recommendations for the use of these substances laid down in Planting Manual No. 1, published by the Institute, does not increase the incidence of bubble formation.

It was found, however, that the addition of as small a quantity as 0.025 per cent by weight of cane sugar brings about an appreciable increase in the quantity of bubbles formed in the prepared sheet, and the increase in bubble formation is proportional to the amount of sugar present. At the end of the year experiments were in progress along similar lines to study the effect of the presence of carbonates in latex and a detailed report on the results obtained are in course of preparation for publication.

The Preparation of a Wide Sheet.

The importance of improving present methods of manufacture and the possible development of an improved type of sheet is engaging the attention of those concerned with the marketing of estate rubber and the assistance of the Chemical Division has been sought in connection with the problems attendant on the manufacture of smoked sheet having a greater width than that normally produced at the present time.

It is thought that the optimum width of sheet rubber should be 18 inches; experimental work has been put in hand to decide this and to arrive at conclusions concerning the optimum dry rubber content of latex, depth of tanks, distance between partitions, and minimum width of machines required. Two sheeting machines with 24 inch rolls have been installed as additions to the existing sheeting battery at the experimental factory and coagulations of different thicknesses and from varying strengths of latex are being tried with the object of preparing the biggest and heaviest type of sheet suitable to the conditions of curing pertaining to the average estate.

Such an investigation is concerned primarily with output per unit time, with the object of reducing cost of manufacture by the saving of labour.

The Drying of Sheet.

The preparation of estate rubber in an improved form is intimately connected with the problem of drying and investigations designed to throw more light on the subject have been put in hand. Following on the work of Van Heurn in Java and O' Brien in Ceylon data on present estate practice in Malaya have been collected. The smoke house attached to the experimental factory is being run under varying

conditions to gain a further insight into the estate figures and in addition a small scale drying room has been fitted up to allow precise control of temperature and air circulation for drying sheet under the most desirable conditions. It is intended to develop the work in the direction of preparing an air-dried sheet free from the defects which have hitherto been associated with that type of rubber, and the possibility of utilizing antioxidants as well as fungicides is receiving attention.

Criteria for Evaluating Raw Rubber.

The value of vulcanisation tests for establishing criteria of utility in rubber investigations is possibly not appreciated by those unfamiliar with such work, and it may not be out of place therefore to record the statement that as a means of gaining information about raw rubber its behaviour during and after vulcanisation is of fundamental importance. For this reason it is essential to the Rubber Research Institute to have at its command the most reliable means of furnishing such information.

During the year under review much work has been devoted to this end. The results of the Java Rubber Conference and informal discussions with representatives of the various research associations have shown the need for further data on points of laboratory technique and considerable attention is now being devoted to the establishment of methods and criteria of universal application and recognition.

In this connection the training of subordinate staff requires time and expert supervision. The past year has witnessed some progress but much still remains to be done. Other criteria for evaluating raw rubber, such as plasticity and resistance to ageing have received some attention and laboratory technique adapted to our conditions has been investigated; the shortage of staff has however precluded any serious attempt at continuity in this direction.

Other internal work has included laboratory investigations into methods for the rapid determination of the dry rubber content of latex, improvements in the Kjeldahl method of nitrogen determination, methods for the analysis of para-nitrophenol, and corrosion tests on various metals which might be suitable for rubber estate utensils.

External Work.

This embraces the investigations which are undertaken outside the Institute. Work of this nature is required in connection with developments in factory practice and the application of laboratory results to industrial conditions.

Lack of staff precluded sufficient attention to requirements in this direction and the Chemical Division was unfortunately not in a posi-

tion to engage in much work that appears to be needed by the industry. Experience during the year has shown an increasing demand for practical assistance in conducting factory investigations and it is evident that this must be encouraged and provided for. With the changing conditions of the market towards improved quality and stricter standards it has become imperative to refine methods of preparation and for this purpose it is essential to devote more attention to suitable trials in estate factories.

In this respect the year under review provides very little to record, but data on smoke houses and fuel consumption were collected from fifty estates and work was initiated in two factories to ascertain the most practical solution to the problem of "sand" in sheet. The presence of "sand" in sheet is a serious defect which has recently been the cause of severe cuts in the market price of crude rubber produced by certain estates. Practical investigations by the Division have shown that the straining of latex as generally practised is useless for eliminating the smaller particles of grit and foreign matter which occurs in latex from the field and where there is any predisposing cause to sand—e.g. tapping at the bottom of a panel—the latex must be diluted and allowed to settle so that the foreign matter can separate out. Some useful pictorial records illustrating our work in this respect have been prepared for publication, and the need for bulking and settling the diluted latex before running it to the coagulating vessels is being impressed on estate managers and agents.

Advisory Work.

The time occupied by advisory work has exceeded that devoted to research. Correspondence with estates as a result of requests for assistance has occupied practically the whole time of one European officer. An analysis of the correspondence which falls naturally into a system of classification similar to that adopted in the previous Annual Report shows that the estate requests are grouped as follows:—

Preparation of sheet	...	40 per cent.
Preparation of crepe	...	10 ,,
Coagulation and factory equipment	...	30 ,,
Latex	...	15 ,,
Estate Chemicals	...	3 ,,

The estate enquiries received by the Division from November 1926 to October 1928 totalled 895 while for the period covered by the present report enquiries of a similar nature totalled 798.

An analysis of these figures shows the following comparison.

	Enquiries in 1927 & 1928.	*Enquiries in 1929.*
Total Enquiries	895	798

The principal enquiries are shown below.

	No.	Per cent.	No.	Per cent.
Sheet.				
Smoke Houses	16	2.2	64	12.5
Bubbles	56	8.0	51	9.9
Moulds	26	3.7	20	3.8
"Rust"	32	4.5	25	4.8
Other Defects	48	6.8	32	6.3
Crepe.				
Drying	—	—	5	1.0
Spot Disease	56	8.0	15	2.8
Defects	—	—	5	1.0
Sole Crepe	26	3.7	17	3.2
Lower grades	—	—	23	4.5
Coagulation & Factory Equipment.				
Hydrometers	38	5.4	30	5.8
Coagulants	43	6.0	13	2.5
Water	46	6.5	31	5.8
Anticoagulants	27	3.8	27	5.0
Tanks	15	2.1	45	8.8
Machines	14	2.0	14	2.5
Latex.				
Packing & Preservation	23	3.1	28	5.6
Dry Rubber Content	22	3.0	40	7.7
Concentration	5	0.7	9	1.6
Chemicals.				
Para-nitrophenol and other fungicides	173	24.0	17	3.0

Visits.

In connection with the above enquiries 52 visits were paid to estate factories compared with 27 for the previous period.

Publications.

The following articles have been published during the year:—

1. Notes on Defects in Smoked Sheet and Crepe Rubber, by R. G. Fullerton. Quarterly Journal, Vol. I. (Nos. 1 and 2).

2. Notes on the Concentration of Latex, by R. G. Fullerton. Idem.

3. The "Dry Rubber" Content of Latex from Deep and Shallow Tapping, by B. J. Eaton and R. G. Fullerton. Quarterly Journal, Vol. I. (No. 3).

4. The Identification and Quantitative Estimation of the Yellow Pigment in Raw Rubber, by B. J. Eaton and R. G. Fullerton. Idem.

5. Factory Economics in the Preparation of Raw Rubber, by B. J. Eaton. Quarterly Journal, Vol. I. (No. 4).

6. A Study of the Effect of Damp Storage on Raw Rubber, by B. J. Eaton and R. G. Fullerton. Bulletin No. 2.

LECTURES.

Lectures were given by Major Eaton, while acting as Director, on "Factory Economics in the Preparation of Rubber" before the Annual Conference of the Incorporated Society of Planters, and the Muar Planters' Association, Johore.

Lectures on "Factory Practice and Defects in Raw Rubber" were also given by the Head of the Division before the Johore Planters' Association at Rengam and the Taiping Branch of the Incorporated Society of Planters, and a lecture on "The Chemist and the Rubber Industry" was given before the local branch of the Institute of Chemistry of Great Britain and Ireland.

Two colloquia were held at which Mr. R. G. Fullerton read a paper on "Hydrogen Ion Determinations and the Coagulation of Latex" and Dr. E. Rhodes read a paper on "Brown Bast."

GENERAL.

The Head of the Division, Major B. J. Eaton, was appointed as one of the delegates of the Institute to attend The Rubber Conference and the Fourth Pacific Science Congress held in Java during May. Valuable information was derived from the papers and discussions at the Conference and from the visits to estates, Government and other scientific institutions and experiment stations.

At a special meeting of the Rubber Conference, proposals were made and adopted for the standardisation of methods in the vulcanisation and testing of rubber at the three principal testing stations, viz: The Proefstation voor Rubber, Buitenzorg, Java, the Rubber Testing Laboratory at the Imperial Institute (Rubber Research Scheme of Ceylon) and the Rubber Research Institute of Malaya.

A programme of work to be carried out at each of the three stations in connection with this problem was approved and is now in hand.

R. O. BISHOP,

Acting Head of Chemical Division.

March, 1930.

ANNUAL REPORT 1929.

BACTERIOLOGIST.

Investigations were undertaken in 1929 under three headings.

(a) Work on soil microbiology,
(b) Nodule formation on leguminous cover plants,
(c) Bacteriology of Hevea latex.

Most of the necessary preliminary work in connection with (a) and (c) has been completed but work on (b) has not advanced very far, the reason being that this investigation requires more time for field work than could be spared. During the latter part of 1929, experimental work on soils and latex was continuous and it was not possible for the writer to be absent from the laboratory. It is hoped, however, that it will be possible to continue research work on cover plants during the early months of the present year.

The programme of work drawn up in January 1929 was adhered to as far as possible but as it is difficult to foresee the duration of any particular investigation, several items on the programme have had to be postponed.

Very little advisory work has been carried out but the reason for this is doubtless that the connection between bacteriology and rubber production is not an obvious one and only in special cases are the various divisions of the Institute unable to supply the required information.

Soil Bacteriology.

Work commenced in 1928 under this heading is still in progress. It is expected that the investigation will throw light on the relationship existing between the rate of decomposition of the organic matter of the soil, the variation in numbers of the bacterial population and the nitrate content of the soil, each of which is of importance as far as conditions on rubber estates are concerned. The absence of low-growing vegetation and the intensity of rainfall in Malaya make for a soil impoverished in organic matter, which condition, in its turn, means a deficiency in the supply of carbon and nitrogen for the growing rubber tree. Before they can be utilised by the plant, the complex organic compounds present in the soil humus have to be broken down by soil bacteria and the carbon and nitrogen made available in the forms of carbon dioxide and nitrate. Once the nitrogen is present as nitrate many factors combine to

remove it from the soil and so out of reach of the plant. Nitrates are readily soluble in water, hence loss occurs by drainage, but a more serious loss is attributable to the fact that many species of bacteria are able to reduce nitrates to ammonia. Under local conditions this ammonia combines with the soil acids but again the soluble salts formed disappear largely in the drainage water. If the soil is poor in organic matter or has a scanty bacterial population or if conditions favour nitrate reduction by the bacteria present, the vegetation will lack an efficient nitrogen supply and, usually, two of these conditions obtain on rubber estates in Malaya.

At temperatures near 25°C., under ordinary conditions, the humus content of the soil is constant, being decomposed by soil micro-organisms at about the same rate as it is formed from dead vegetation. At temperatures below 25°C., there is an accumulation of humus in the soil for it is formed faster than it is decomposed, but at temperatures near 30°C. (i.e. under local conditions) the decay of soil organic matter outpaces its formation so that soils tend to become deficient in humus. On rubber estates without a cover of any sort, the supply of decaying plant material is strictly limited from the start so that once the soil is deficient in humus there is little hope of its acquiring a further reserve supply.

(a) Decomposition of soil organic matter.

The living plant obtains it supply of carbon from the carbon dioxide of the air, in which conditions it is absorbed by the green parts of the plant and then goes to build up more complex compounds such as carbohydrates and proteins. On the death of the plant the organic compounds are returned to the soil but, before the carbon contained in them is available again as plant food, numerous bacterial decompositions take place and finally the carbon appears as carbon dioxide gas and the cycle is repeated.

Thus, the carbon dioxide evolved by a soil gives a measure of the rate of decomposition of the organic matter present and may be regarded as an index of the fertility of the soil.

Several different types of soil have been examined by measuring the carbon dioxide evolved at regular intervals and although the curves obtained by plotting total carbon dioxide evolved against time are in all cases of the same type, the rates of decomposition are by no means the same. The decomposition rate is greatest during the first few days of the experiment, then it gradually decreases, and continues to decline although the slowing-down process is usually very gradual.

It was found that humus decomposition occurred most rapidly in a peat soil which had been limed; a garden soil gave very poor results. A forest soil was tested with (a) the micro-organisms normally present in the soil, (b) one species of bacteria, (c) Actinomyces.

The results for (a) fell between those for the limed peat soil and the garden soil, (b) was perceptibly slower, while (c) was much slower and the rate of decomposition declined rapidly. A very marked increase in the carbon dioxide production occurred in a soil containing rubber seeds. This investigation is still proceeding.

(b) Bacterial population of the soil.

During 1929 determination were made, at weekly intervals, of the number of bacteria present in the soil on a selected site at the Rubber Research Institute Experiment Station at Sungei Buloh. The spot chosen was under jungle in January and February and the experiment was continued during the subsequent operations of clearing, burning off and planting with rubber seedlings.

In England, under the same experimental conditions as were employed here, from 1 to 5 million bacteria normally occur in one gramme of soil. Except under special conditions, it has been found that the bacterial population of Malayan soils usually falls far below this value.

From the figures obtained, it appears that the normal bacterial population of the soil on the plains is under one million per gramme. Probably the soils on the hills support a more flourishing micro-organic population and it is hoped to test this point in the near future.

After the jungle has been felled, the numbers show a tendency to fall and to remain stationary at about half a million per gramme. Burning operations, however, result in a big increase, which is maintained for a few weeks, and then the numbers fall to the half million mark again.

An idea of the numbers obtained may be gleaned from the following table:

Bacteria per gramme of soil.	*Number of occasions.*
Under 1 million ...	54
Between 1 and 2 million ...	13
Between 2 and 5 million ...	5
Over 5 million ...	7

The high counts were invariably associated with burning operations.

The interpretation of the results appears to be as follows: Under virgin jungle, the mean temperature of the soil is in the neighbourhood of 25°C. and at this temperature humus formation and decomposition proceed at the same rate Hence conditions approach that of equilibrium and the bacterial content of the soil is probably reasonably constant and about 1 million bacteria per gramme. At higher temperatures, such as obtain on unshaded bare soil, decomposition of the humus proceeds but the sun has doubtless some sterilising

effect on soil organisms so that lower bacterial counts are to be expected. The important point, however, is that the soil humus and its products of decomposition are disappearing and not being utilised as plant foods. Moreover, the supply is not being replenished and, in consequence, the micro population of the soil gradually decreases and less of the essential plant foods, carbon dioxide and nitrate, are being manufactured.

During burning operations, and for a few weeks after a big increase in bacterial numbers is evident and this is due, in part, to the fact that wood ash contains alkaline consituents which in some measure neutralise the acidity of the soil and, temporarily, create conditions more favourable to bacterial growth. This effect, however, is very evanescent and after a shorter or longer interval, dependent on the rainfall, conditions revert to what must be considered as normal. A further effect of the wood ash present may be that certain of its constituents have a stimulating action on bacterial growth but, under the circumstances, this increased bacterial population is not desirable for it indicates a speeding up of humus decomposition with loss of plant nutrients in the air and drainage water.

Planting of rubber seedlings has little or no effect on humus decay or bacterial numbers.

Viewed from the standpoint of the biochemist, it is regrettable that such a long period should elapse between jungle felling and rubber planting and there is much to be said for the plan of planting a rapidly growing cover such as Crotalaria at the earliest possible moment for in this way some measure of humus conservation can be effected.

(c) Actinomyces.

In order to interpret correctly the results of a number of experiments with soil bacteria, it was deemed advisable to carry out some investigations on one species of soil organism in pure culture. A strain of a species of Actinomyces occurring in local soil was supplied by Mr. F. Beeley and this organism was considered to be suitable for the purpose. Moreover, the rôle played by Actinomyces in the soil is not yet thoroughly understood so that such a study has a practical as well as a theoretical interest.

The Actinomyces was grown in a solution of glucose and the carbon dioxide evolved as a result of the decomposition of the sugar was determined daily. It was found that the whole of the glucose disappeared and all the carbon originally present finally appeared as carbon dioxide. The curve obtained by plotting the total carbon dioxide liberated against the time is sigmoid in shape, closely resembling an ordinary growth curve for bacteria.

When sterile soil was inoculated with the same species of Actinomyces, and the experiment repeated, quite a different type of curve was obtained. In this instance the curve resembles that obtained from soil with ordinary soil micro-organisms.

It has been found that the species of Actinomyces in question is able to decompose dead vegetative matter and the decomposition proceeds most rapidly in a moist atmosphere. The organism is unable to withstand exposure to sunlight.

This work has not yet been completed so it is not possible to do more than outline the nature of the investigation.

Nodule Formation on Leguminous Cover Plants.

Although the use of leguminous plants as a cover on rubber estates is rapidly becoming widespread in Malaya, this practice is not invariably attended with success. In most cases the plants selected are not indigenous to the Peninsula so that it might be anticipated that some difficulties would attend their establishment. It is well-known, of course, that plants of the order Leguminosae find favour because, by means of nodules formed on their roots, they are able to obtain nitrogen directly from the air. Other plants have to depend solely on the nitrates in the soil solution for their supply of the element nitrogen.

The nodules on the roots of leguminous plants are produced by bacteria of the genus *Rhizobium* (Frank) and they appear to be ubiquitous for, although nodule formation may often be very poor, it is not often that leguminous plants are encountered without any nodules at all.

The relationship existing between the plant and the bacteria is symbiotic. As the bacterial population grows, the nodules increase in numbers and size and increasing amounts of nitrogen from the air are "fixed." Eventually, the leguminous plant gets the benefit of this extra nitrogen supply.

It is evident then that the reason for selecting a leguminous plant as a cover is a sound one but, if nodule formation is very poor or non-existent, there is no particular reason why other plants, if otherwise suitable, should not find favour.

The work of the bacteriologist is concerned primarily with nodule formation and, in this connection, two questions are of importance as far as the use of leguminous covers on local estates is concerned.

(1) Is there a direct relationship between vigorous growth of the plant and good nodule formation on the roots?

(2) What are the conditions locally which favour strong nodule formation?

It is tacitly assumed that good nodule production results in more vigorous plant growth but this is a point which requires to be defi-

nitely settled as far as *Dolichos hosei* (Vigna), for example, is concerned. Even if there is not an obvious connection between growth and nodule formation, it is highly desirable that a good supply of nodules should be present for a large proportion of the nitrogen contained in a legume with normal nodules originally came from the air. In fact, a recent investigation (O. H. Sars, Univ. of Illinois, Circular No. 326, 1928) places this proportion as high as two-thirds of the total present.

With regard to the second question, this subject is rather confusing for it is not easy to pick out the factor or factors which determine strong nodule formation under local conditions. The life cycle of *Rhizobium radicicola* (Beij.) is known and it has proved to be rather complex. Only during one stage of the cycle is the organism motile and it has been found that the occurrence of this motile stage is favoured by the presence of phosphates. Another observation which may throw light on the question is the fact that leguminous plants almost invariably flourish on limestone soils. In this connection, attention may be drawn to the luxuriant growth of Vigna (and probably other leguminous covers) on sites where tree stumps have been burnt. Wood ash contains a higher proportion of calcium than of any other metal though potassium is also present in large proportion but, from experiments carried out here, however, it appears to be almost certain that it is not potassium which is responsible for the stimulation of growth.

We have yet to ascertain whether the calcium has a direct effect on the nodule bacteria or whether the result is due to a consequent fall in the soil acidity. Nodule bacteria are sensitive to changes in soil acidity and the limiting degree of acidity is, in many cases, only just above that of the soils usually encountered on rubber estates. From work carried out here, however, it seems probable that the part played by lime in neutralising soil acids is only of secondary importance compared with that of stimulating plant growth or nodule formation.

Although the work has not yet reached an advanced stage it can be safely stated that nodule formation on Vigna is stimulated by applications of fertilisers containing lime and small quantities of phosphate.

It may be as well to point out that it is of little use trying to establish covers on the sub-soil obtained from newly dug silt pits. In such cases, the limiting factor is the organic matter present and no amount of mineral fertilisers can supply the deficiency.

In some countries a considerable amount of work has been carried out on soil inoculation. This procedure was adopted when leguminous plants were found to be without nodules, when a particular legume was about to be grown on a reclaimed soil upon which it had not been previously grown or when nodule formation was very

poor. In the first two cases the experiments have been attended with success but inoculation of soils already containing the *Rhizobium* organisms has proved of little value.

It seems probable that inoculation of local soils which already contain leguminous covers with poor nodule formation will not be highly successful and one or two experiments carried out here are in accordance with this view.

Much work yet remains to be done on this subject and it is hoped that more time will be available for its prosecution during the present year.

The Bacteriology of Latex.

The practical importance of the bacterial population of latex to the rubber industry can hardly be overestimated. Our knowledge of this subject is very meagre at present. The occurrence of certain micro-organisms in latex is probably fairly general and Hevea latex may be regarded as having a flora of its own much in the same way as certain bacteria are almost invariably associated with milk.

There is every reason for believing that latex in the tree is sterile and that it collects its organic population subsequent to its emergence from the tapping cut. Some contamination occurs at the tapping cut and each subsequent stage in the operations to which latex is subjected results in additions to its micro-flora. The only species whose presence has any significance are those which are able to decompose the constituent compounds of latex and once these organisms have gained access to latex they are able to multiply rapidly and hence some of them are always present in the field or factory waiting to contaminate latex at the opportune moment. Some latex organisms are able to grow faster than others so it seems probable that a few species are to be found always in latex throughout the country. When a systematic study of latex organisms in Malaya has been completed it would be of considerable interest to investigate the micro flora of latex in other rubber producing countries, for a different bacterial population would doubtless result in a slightly modified final product.

The bacterial population of latex is of industrial importance in several respects. Natural coagulation can only take place when certain bacteria are present and, hence, the question of preservation of latex resolves itself into one of bacteria control. During the time which elapses between tapping and coagulation, bacteria are at work in the latex and many of the chemical reactions for which they are responsible must be such as to modify the properties of the final product in uncertain ways.

The occurrence of bubbles in sheet rubber is sometimes, if not invariably due to the presence of one or more species of bacteria

and it should be possible to eradicate the source of the trouble with little or no difficulty. Doubtless, these examples could be multiplied but they are cited to show that the bacteriology of latex is a matter on which some control could be exercised.

As our present knowledge is so scanty, the first step was to isolate some of the more frequently occurring organisms and study their properties. During the past year a considerable advance has been made along these lines and eight organisms have been studied in detail. Few latex organisms grow on ordinary media so a special medium had to be devised and this, up to a point, has proved successful.

The most important species studied was a bacillus which was responsible for most of the more noticeable changes which occur in latex. An account of this organism has been published and it may be pointed out here that the bacillus in question is responsible for:—

(a) production of an acid serum and hence
(b) flocculation of the rubber particles,
(c) an alkaline surface layer,
(d) ammonia production.

This bacillus differs from many of the other latex bacteria in its inability to produce hydrogen sulphide from latex. As it appears to be a new species it was denominated *Bacillus pandora* by the writer.

The activities of this organism have to be considered in connection with the preservation of latex by ammonia for shipment. Experiments have shown that ammonia, in the concentrations in which it is usually employed, has no toxic effect on the bacillus and its action is one of acid neutralisation. This means that ammoniated latex undergoes decomposition throughout the journey and it would be of interest to make a biochemical and bacteriological study of "preserved" latex after storage.

It is not suggested that only one organism can effect latex flocculation but so far no other bacteria have been found which can effect this change in anything but a very slight degree.

Of the other bacteria isolated from latex, the most interesting is a micrococcus which is able to produce both gas and acid from latex serum. This organism is probably the cause of bubbles in sheet rubber but its eradication should present no particular difficulty as, unlike the bacillus previously discussed, it is not a spore former. The micrococcus resembles *B. pandora* in several important respects; it can produce ammonia but not hydrogen sulphide and is able to reduce nitrates. Although it produces acid in latex this action is not very marked and its flocculating action on the rubber particles is very feeble.

Only one spore former occurs among the remaining six organisms isolated and this, a species of *Gaffkya* (Trevisan), is the most peculiar bacterium so far encountered. It is able to produce ammonia and

a yellow surface layer on latex but this latter property is shared by another species.

Of the eight types considered, all except one produce ammonia, two produce acid and two produce hydrogen sulphide though two or three others do so feebly. It might appear that alkali production predominates but actual observation shows that the acid producing organisms have matters their own way during the natural course of events. Only two of the organisms considered are able to form spores.

Several of the species studied appear to be identical with certain organisms isolated from latex in Indo-China by Dernier and Vernet (Compt. rend., 1917, **165**, 123).

A. Steven Corbet,

Bacteriologist.

March, 1930.

ANNUAL REPORT 1929.

EXPERIMENT STATION.

The total area of the Institute's Experiment Station, which is situated in the Sungei Buloh Forest Reserve, 16 miles from Kuala Lumpur, is 2000 acres. The following details show the development of this area at the end of 1929:

1. Acreage Statement.

The position as at 31st December, 1929 was as follows:—

Planted	...	571½	acres.
Holed and filled	...	23	,,
Lined	...	50	,,
Cleared (to be planted)	...	28½	,,
,, (not to be planted)	...	2	,, (Block 9a)
Felled (remaining to clear)	...	93	,,
		768	,,
Elephant belt	...	67	,,
Building site	...	70	,,
Total area opened	...	905	,,
Jungle Reserve	...	1095	,,
Area under application	...	2000	,,

2. Distribution of Land.

Botanical Division	...	301	acres.
Soils ,,	...	172	,,
Pathological ,,	...	210	,,
General (Blocks 22 & 23)	...	85	,,
		768	,,
Building site	...	70	,,
		838	,,

The work of extracting jungle produce from areas opened caused much delay in the progress of clearing operations as the contractors, finding the market for firewood depressed, would not remove the cut timber immediately.

3. Clearing.

Area cleared in 1928 ...	200	acres.
,, ,, ,, 1929 ...	475	,,
Total ...	675	,,

Details of area cleared in 1929:—

Block 14 clean cleared ...	97	acres.
,, 15 ,, ,, ...	78	,,
,, 17 ,, ,, ...	4	,,
,, 20 & 21 ,, ,, ...	50	,,
Total ,, ,, ...	229	,,

Block 16 cleared surface timber and 9 inch. stumps	40	acres.
,, 17 ,, ,, ,, ,,	36	,,
,, 18 ,, ,, ,, ,,	78	,,
,, 19 ,, ,, ,, ,,	59	,,
,, 24 ,, ,, ,, ,,	33	,,
	246	,,
Total clean cleared	229	,,
	475	,,

In the 97 acres clean cleared in Block 14, one acre was clean cleared without burning. Apart from this, 475 acres of land were cleared for cultivation, and a further 70 acres were clean cleared for building site. The 40 acres in Block 5 which were cleared up to 9 inch stumps in 1928 were again clean cleared for budding experiments.

In Block 16, wherever stumps came in the line of planting, they were removed.

In Blocks 18 and 19 the swampy nature of the land retarded clearing to a certain extent.

4. Holing and Filling. An area of 444½ acres was holed and filled during the year for normal planting as follows.

Block.	Area.	Spacing.	Dimensions of holes.
3	8 acres	20 ft. × 20 ft.	2 ft. × 2 ft. × 2 ft.
4	3 ,,	,,	,,
5	40 ,,	,,	3 ft. × 3 ft. × 2½ ft.
10	10 ,,	22 ft. × 22 ft.	2 ft. × 2 ft. × 2 ft.
11	5 ,,	,,	,,
11	5 ,,	22 ft. × 11 ft.	,,
13	2½ ,,	22 ft. × 22 ft.	,,
14	1 ,,	,,	2 ft. × 2 ft. × 2 ft.

14	19	,,	30 ft.	×	30 ft.	,,
14	20	,,	20 ft.	×	20 ft.	,,
14	20	,,	14 ft.	×	14 ft.	,,
14	20	,,	12 ft.	×	12 ft.	,,
14	20	,,	10 ft.	×	10 ft.	,,
15	78	,,	20 ft.	×	20 ft.	,,
16	35	,,		,,		,,
17	28	,,	22 ft.	×	22 ft.	,,
19	47	,,		,,		,,
20	25	,,		,,		,,
21	25	,,	30 ft.	×	30 ft.	,,
24	33	,,	22 ft.	×	22 ft.	,,
	444½					

Block 5 (40 acres)—holes filled with good earth and cow-dung mixed. Crowbar planting was the method adopted in Block 18.

5. Planting. The area of normal planting during the year was as follows:—

Block	2	...	10	acres.
,,	3	...	8	,,
,,	4	...	10½	,,
,,	5	...	40	,,
,,	10	...	10	,,
,,	11	...	10	,,
,,	13	...	2½	,,
,,	14	...	70	,,
,,	15	...	33	,,
,,	16	...	31	,,
,,	17	...	23	,,
,,	18	...	66	,,
,,	19	...	64	,,
,,	20	...	25	,,
,,	21	...	25	,,
,,	24	...	33	,,
			461	,,

Block 2. 10 acres were planted in 1929. Tjikadoe seed from Seed Gardens (Nos. 1—25) were received, germinated in the Botanical Division nursery and planted out in this area to a total of 347 seedlings.

Block 3. This area was previously planted with Puchong Estate seed and has now been interplanted 22 ft. × 11 ft. with mixed Tjikadoe seedlings.

Block 4. (Portion reserved for Mr. Morris)—The planting of this area was completed.

,, (Portion reserved for Mr. Kaimal)—2 acres are planted with stumps and twin seedlings for experimental purposes.

Block 5. This area was planted with budded stumps, budding taking place in the Botanical Division Nursery and at Jinjang Estate.

Block 10. This was planted with seed at stake.

Block 11. This was planted one-third with seed at stake, one-third with basket plants and one-third with stumps. This field is being allowed to revert to secondary jungle, only small weeds and lallang being extracted.

Block 13. $2\frac{1}{2}$ acres were planted with seedlings.

Block 14. (Block 14a) One acre was planted one-third with seed at stake, one-third with basket plants and one-third with stumps.

Block 14. 69 acres were planted with Ranston Estate seed at stake germinated at our nursery, for density experiment.

Block 15. 33 acres were planted with seed at stake.

Block 16. 31 acres were planted with crosses and controls brought from the Institute by Mr. Morris.

Block 17. 23 acres were planted with seed at stake. A portion of this field (18 acres) is allowed to grow in indigenous grasses and the balance of 22 acres in different cover-crops.

Block 18. 66 acres were crowbar-planted with stumps. The lining was 20 ft. × 20 ft. and at each hole two stumps were put in at one foot apart.

Block 19. 64 acres were planted with seed at stake—2 seeds to a hole.

Block 20 & 21. 50 acres were planted one-third with seed at stake, one-third with basket plants and one-third with stumps.

Block 24. 33 acres were planted with seed at stake—2 seeds to a hole.

Block 17, 19 & 24. 60 acres were interplanted 22 ft. × 11 ft. This area will be completed early next year.

6. Nurseries. 3 acres of nurseries were laid down in Pathological Division (Block 12) for disease experiments and budding work. 50 budded stumps from the best known AVROS clones were planted in this nursery on their arrival from Sumatra.

5 acres of Block 13 nursery are composed of various cover crop plots ($2\frac{1}{2}$ acres planted with rubber).

2 acres of Block 17, Soils Division nursery, is also planted with different cover-crops where shading and manuring experiments will take place in due course.

7. Roads and Bridges. 157 chains of roads were metalled and a further 53 chains of earth work were completed during the year. The swamp in Block 18 caused considerable difficulty, as on this the road had to be raised and a culvert laid.

The new Government road across Blocks 16 and 17 was completed. I have to record my thanks to the Public Works Department for their advice and for loan of their roller for a period.

8. Drainage. Intensive drainage work was done over the whole cleared area, special attention being paid to the anti-malarial drains in Blocks 17, 18 and 19. Sungei Payong is now deepened whereby better drainage is effected.

Cement drains, which will be the permanent outlets for the lines and bungalows were laid in Blocks 2, 3 and 16.

9. Terracing, Silt pitting and Bunding. The hill in Block 24 was terraced. In Block 19 the hilly area was silt pitted with continuous bunds above pits.

Blocks 2, 4, 5, 6, 8, 10, 12, 13, 16 and 17 were bunded in 7 chain squares of 18 inches height. The spoil for bunds was won from narrow trenches cut at right angles to bunds.

10. Levelling. In Block 5, the holes from stumping during clean-clearing were levelled. Considerable levelling was done at lines and bungalows on the building site.

11. Cover Crops. The planting of the cover crop nurseries in Blocks 13 and 17 was completed.

In Blocks 5, 19 and 24 Vigna was planted; in Blocks 15 and 18 Centrosema Pubescens was dibbled in; in Block 16 Calapogonium mucunoides was planted. Supplying was done where needed in areas previously planted.

12. Pests and Diseases. Rats, grass-hoppers and crickets have caused slight damage to plants, but the use of traps and wire guards for plants is considerably reducing the amount of damage done by these pests.

Black scale was observed in Block 4 Nursery and on several plants in Blocks 2 and 4. The use of a mixture of kerosine oil and soap solution, sprayed over the plants, arrested this trouble.

Elephants from time to time have been seen in the Western boundary but the 2 chain elephant belt has proved most effective in keeping these animals off the Station.

Experimental work on root diseases etc. has been carried on at the Station by the Pathological Division staff.

13. Health. Owing to the large amount of clearing done, especially in the two swamps on either side of the building site, and also to Chinese squatters keeping their kongsies dirty a considerable number of cases of malaria have been found. Efficient measures

as regards anti-malarial drainage and oiling are being taken, and it is hoped that, as these swamps are now drying up rapidly, the health will be good.

A competent dresser was engaged and a dispensary was equipped.

14. Exploiting Jungle. The matter has not progressed owing to the depressed state of the timber market.

15. Buildings. During the year the following buildings have been erected:—

1. Manager's Bungalow.
2. Guest House.
3. Three Clerks' Bungalows.
4. Office.
5. Dispensary.
6. Pathological Division Tool Shed.
7. Tool and Rice Store.
8. Hostel.
9. Watchman's House.
10. Twenty semi-detached cooly lines.
11. School and Temple.

The building of the Guest House was interrupted by the contractor quarrelling with his coolies and he was dismissed. A new contractor was engaged to complete the work.

In the Guest House a septic tank installation was installed which is so far successful.

Wells and temporary pipe lines for drinking water were erected in the lines.

16. Reserve Jungle Survey. Messrs. Booty and Edwards completed a survey of the reserve area which was again inspected by Mr. D. S. Gardner, our Visiting Agent, who reported favourably on the type of land.

17. General. On 7th May, 1929, I took over the management from Mr. D. S. Gardner who became Visiting Agent.

A special visit was paid by the Director of Agriculture and the Director of the Institute with their Field Officers on the 11th October, 1929.

Many visitors are now coming to the Station.

The labour force seem to like the Station and, given good health, there appears to be no reason why a permanent and contented labour force should not be available for our requirements.

Budding in the nurseries under Mr. C. E. T. Mann was carried out and successes were very favourable; two gangs of budders were available for estates.

I went into hospital early in December with malaria and paratyphoid; Mr. H. B. Wilkinson acted for me.

The work of completing the large programme for 1929 was difficult and I wish to record my thanks to the Asiatic staff who worked very well under trying conditions.

In conclusion I would like to take this opportunity of thanking the Scientific staff of the Institute who are working on the Station for their help and co-operation and also Mr. D. S. Gardner for the advice and assistance he has so willingly given during the year.

H. W. Foston,

Manager.

March, 1930.

THE RUBBER RESEARCH INSTITUTE OF MALAYA.

(Incorporated.)

BALANCE SHEET AS AT 31st DECEMBER, 1929.

LIABILITIES.

	$ c.	$ c.
SUNDRY CREDITORS		
At Experiment Station	22,858 17	
Board and Committee Members Fees and Expenses	1,121 65	
Travelling Claims of Staff	1,080 47	
Sundry Other Creditors	5,623 75	30,684 04
DEPOSITS		
For Future Publications .. .		167 64
SUSPENSE ACCOUNT		
Rent for Bungalows received in advance		212 45
RESERVES		
Staff Leave Pay: $ c.		
At 31st December 1928 54,586 52		
Add Reserve for 1st half year, 1929 17,187 00		
Add Reserve for 2nd half year, 1929 15,473 00		
87,246 52		
Less paid during year 34,037 82	53,208 70	
Carried forward	53,208 70	31,064 13

ASSETS.

	$ c.	$ c.	$ c.
LAND AND BUILDINGS—			
1. 132, Ampang Road:			
Land as per last Balance Sheet		10,755 00	
Ampang Villa Building as per last Balance Sheet ..	17,028 76		
Less depreciation for year ..	448 12	16,580 64	
Director's House as per last Balance Sheet	43,865 17		
Less depreciation for year ..	1,154 34	42,710 83	70,046 47
2. Land behind Ampang Villa:			
As per last Balance Sheet ..			5,001 35
3. 5, Circular Road:			
Land as per last Balance Sheet		17,147 08	
Old Building as per last Balance Sheet	13,384 95		
Less depreciation for year ..	352 24	13,032 71	
Three Houses:			
As per last Balance Sheet	74,449 17		
Less depreciation for year..	1,959 19	72,489 98	102,669 77
Carried forward			177,717 59

LIABILITIES—(*cont.*)

		$ c.	$ c.
Brought forward		53,208 70	31,064 13
Staff Passages:			
At 31st December, 1928	22,540 13		
Add Reserve for 1st half year, 1929	5,024 00		
Add Reserve for 2nd half year, 1929	3,465 00		
	31,029 13		
Less paid during year	7,128 08	23,901 05	77,109 75
GOVERNMENT LOAN OF $750,000.00—			
Amount drawn to date			100,000 00
ACCUMULATED FUND—			
Balance at 31st December, 1928 ..		816,432 44	
Add Excess of Income over Expenditure during year		185,118 48	1,001,550 92
Carried forward ..			1,209,724 80

ASSETS—(*cont.*)

		$ c.	$ c.	$ c.
Brought forward				177,717 59
4. 163, Ampang Road:				
Land as per last Balance Sheet			31,440 35	
Old Building as per last Balance Sheet		12,732 04		
Less depreciation for year ..		335 05	12,396 99	
First Five Houses:				
As per last Balance Sheet		87,354 09		
Less depreciation for year ..		2,298 79	85,055 30	128,892 64
5. 3¼ mile, Ampang Road:				
Land as per last Balance Sheet			45,422 50	
Second Five Houses as per last Balance Sheet ..		71,277 40		
Add Additions during year ..		4,525 35		
		75,802 75		
Less depreciation for year ..		2,053 90	73,748 85	119,171 35
LABORATORY BUILDINGS AT 2¾ MILE, DAMANSARA ROAD—				
As per last Balance Sheet ..		80,213 89		
Add additions during year ..		56 36	80,270 25	
Less depreciation for year ..			11,467 18	68,803 07
Carried forward				494,584 65

BALANCE SHEET AS AT 31st DECEMBER, 1929 *(cont.)*

LIABILITIES *(cont.)*

	$ c	$ c	$ c
Brought forward			1,209,724 20
Carried forward			1,209,724 20

ASSETS *(cont.)*

	$ c	$ c	$ c
Brought forward			494,584 65
PLANT AND MACHINERY			
Electric Plant:			
As per last Balance Sheet ..	9,571 82		
Add additions during year ..	145 00		
	9,716 82		
Less depreciation for year ..	2,429 20	7,287 62	
General Machinery:			
As per last Balance Sheet ..	25,940 13		
Add additions during year ..	195 00		
	26,135 13		
Less depreciation for year ..	3,920 27	22,214 86	29,502 48
BUNGALOWS FURNITURE			
As per last Balance Sheet		40,930 91	
Add additions during year		176 58	
		41,107 49	
Less returned during year		292 30	
		40,815 19	
Less depreciation for year		3,061 14	37,754 05
Carried forward			561,841 18

BALANCE SHEET AS AT 31st DECEMBER, 1929 (*cont.*)

LIABILITIES (*cont.*)

	$ c.	$ c.
Brought forward		1,209,724 80
Carried forward		1,209,724 80

ASSETS (*cont.*)

	$ c.	$ c.	$ c.
Brought forward			561,841 18
OFFICE FURNITURE AND EQUIPMENT			
As per last Balance Sheet		13,251 47	
Additions during year		393 20	
		13,644 67	
Less depreciation for year		1,023 35	12,621 32
LABORATORY FURNITURE			
Purchased during year		1,200 73	
Less depreciation for year		90 05	1,110 68
STORE FURNITURE			
Purchased during year		248 80	
Less depreciation for year		18 66	230 14
LIBRARY FURNITURE			
Purchased during year		642 58	
Less depreciation for year		48 17	594 41
LABORATORY EQUIPMENT AND APPARATUS			
As per last Balance Sheet		58,898 86	
Add additions during year		11,069 49	
		69,968 35	
Less depreciation for year		13,992 87	55,975 48
Carried forward			632,373 21

LIABILITIES—(*cont.*)

	$ c.
Carried forward ..	1,209,724 80
Carried forward	**1,005,662 48**

	$ c.	$ c.	$ c.
Brought forward			632,373 21
LIBRARY BOOKS AND PERIODICALS—			
As per last Balance Sheet		1 00	
Purchases of Books during year ..		1,523 35	
Purchases of Periodicals		2,461 05	
		3,985 40	
Less depreciation for year		3,984 40	1 00
MOTOR LORRY—			
As per last Balance Sheet		1,188 14	
Less depreciation for year		297 03	891 11
R.R.I. EXPERIMENT STATION—			
Capital Expenditure to date			366,403 75
WORKSHOP EQUIPMENT			1,347 59
STOCKS IN HAND—			
Petrol and Oil		176 02	
Empty Petrol tins		7 00	
Stationery		547 49	
Teak Planks		156 36	886 87
PAYMENTS IN ADVANCE—			
Against Orders placed		1,396 07	
Against Telephone Subscriptions Insurance premium, etc.		2,362 88	3,758 95

BALANCE SHEET AS AT 31st DECEMBER, 1929—(*cont.*)

Carried forward ..	1,209,724 80

LIABILITIES—(*cont.*)

	$	c.
Brought forward	1,209,724	80
Brought forward	1,209,724	80

ASSETS—(*cont.*)

	$	c.	$	c.	$	c.
Brought forward					1,005,662	48
SUNDRY DEPOSITS—						
Against Water Supplies, Telephones, etc.					110	00
ADVANCES TO STAFF FOR MOTOR CARS, ETC.—						
Senior Staff			1,444	66		
Junior Staff			2,793	29	4,237	95
SUNDRY DEBTORS—						
F.M.S. Government			37,682	34		
S.S. Government			45,000	00		
Kelantan Government			2,895	31		
Kedah Government			1,750	00		
Trengganu Government			780	42		
			88,108	07		
At Experiment Station ..	4,215	36				
Sale of Publications	149	49				
Sundry Other Debtors ..	971	57	5,336	42	93,444	49
CASH AT BANK AND IN HAND—						
Rubber Growers' Association, London			857	25		
Chartered Bank, London ..			5,549	97		
Chartered Bank, Kuala Lumpur:						
Board's Account	16,133	81				
Working Account	5,457	60				
	21,591	41	6,406	22		
Carried forward					1,103,454	92

BALANCE SHEET AS AT 31st DECEMBER, 1929—(*cont.*)

LIABILITIES—(*cont.*)

	$ c.	$ c.	$ c.
Brought forward			1,209,724 80
Brought forward			1,209,724 80

ASSETS—(*cont.*)

	$ c.	$ c.	$ c.
Brought forward	21,591 41	6,406 22	1,103,454 92
Less Experiment Station over drawn	553 55	21,037 86	
Mercantile Bank, Kuala Lumpur		78,673 58	
Petty Cash:			
Laboratory	152 92		
Less Experiment Station over drawn	1 70	151 22	106,269 88
			1,209,724 80

(Sd.) V. LOUIS CACHEMAILLE,
Secretary.
16th January, 1930.

(Sd.) H. A. TEMPANY,
President.
25th January, 1930.

We have audited the above Balance Sheet and Income and Expenditure Account with the books and vouchers of the Rubber Research Institute and certify same to be correct according to the best of our information and explanations given us and as shewn by the books of the Institute.

Kuala Lumpur,
16th January, 1930.

(Sd.) GIBSON ANDERSON BUTLER & Co.,
Chartered Accountants,
Auditors.

Dr. INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1929. *Cr.*

EXPENDITURE.

	$ c.	$ c.	$ c.
To London Advisory Committee—			
Expenses			63 61
,, Board and Committee Meetings—			
Fees to Members		4,334 50	
Expenses of Members		2,021 73	6,356 23
,, Salaries and Allowances—			
1. Senior Staff:			
(a) General and Office	18,030 00		
(b) Research	152,836 23		
(c) Field	21,455 12	192,321 35	
2. Junior Staff:			
(a) Office Clerks	10,405 13		
(b) Research Assistants	14,034 19		
(c) Field Conductors	4,845 72		
(d) Laboratory Attendants	2,158 00	31,443 04	223,764 39
,, Provident Fund—			
1. Contributions:			
(a) Senior Staff	9,829 21		
(b) Junior Staff	770 43	10,599 64	
2. Administration Expenses ..		199 50	10,799 14
,, Staff Recruiting Expenses			2,618 77
Reserve for Staff Leave Pay ..			32,660 00
,, Reserve for Staff Passages			8,489 00
,, Medical and Hospital charges ..			1,238 56
,, Dental Treatments			909 00
,, Travelling Expenses of Staff ..			12,569 86
Carried forward			299,468 56

INCOME.

	$ c.	$ c.
By Contributions received—		
F.M.S. Government, January to November	399,813 28	
S.S. Government, on account of 1929	50,000 00	
Johore Government, January to December	50,000 00	
Kedah Government, January to November	19,250 00	
Kelantan Government, January to September	10,837 69	
Trengganu Government, January to September	2,933 93	532,834 90
,, Contributions due and not yet received—		
F.M.S. Government, December ..	37,682 34	
S.S. Government, balance 1929 ..	45,000 00	
Kedah Government, December 1929 ..	1,750 00	
Kelantan Government, 4th Quarter 1929	2,895 31	
Trengganu Government, 4th Quarter 1929	780 42	88,108 07
,, Sinking Fund Reserve for 1928— Written off		400 00
,, Miscellaneous Receipts—		
Bank Interest etc., for year ..	3,788 40	
Sales of Rubber	496 29	
Bungalow rents	1,754 38	6,039 07
Carried forward		627,382 04

Dr INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1929—(*cont.*) *Cr*

EXPENDITURE—(*cont.*)	$ c.	$ c.
Brought forward		299,468 56
To Library—		
Subscriptions to Newspapers ..	150 57	
Salaries of Staff	5,774 29	
Sundry Expenses	711 16	6,636 02
,, General Office Charges—		
Stationery and Printing	1,466 85	
Postages and Telegrams	764 12	
Audit Fees	1,325 00	
Legal Fees	427 00	
Telephone Subscription and T'calls ..	1,470 20	
General Expenses	798 64	6,251 81
,, Rents, Rates and Insurance, etc. ..		5,563 81
,, Laboratory Equipment & Apparatus—		
Replacements and upkeep of ..		5,635 58
,, Laboratory Chemicals		3,018 72
,, Laboratory Photographic Chemicals ..		269 98
,, Laboratory Glassware		1,891 34
,, Laboratory General Charges		2,726 37
,, Pathological Division Field Experiments		406 04
,, Small Holdings Survey		437 99
,, Upkeep Library Furniture		4 83
,, Upkeep Office Furniture		21 72
,, Upkeep Bungalows and Furniture ..		1,379 85
,, Upkeep Laboratory Buildings and Furniture		1,201 48
,, Upkeep Laboratory Grounds ..		559 22
,, Upkeep Workshop		40 16
,, Lorry Working		1,582 11
Carried forward		337,095 59

INCOME—(*cont.*)	$ c.	$ c.
Brought forward		627,382 04
By Publications—		
Sale Proceeds of:		
Manual No. 1	715 44	
Manual No. 2	743 25	1,458 69
Carried forward ..		628,840 73

Dr INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1929—(*cont.*) *Cr*

EXPENDITURE—(*cont.*)	$ c.	$ c.
Brought forward		337,095 59
To Plant and Machinery—		
Repairs and Upkeep	1,837 42	
Running Expenses	5,452 39	7,289 81
,, Interest on F.M.S. Government Loan ..		3,375 00
,, Exhibitions, Shows, etc.—		
M.A.H.A. Exhibitions		174 51
,, Publications—		
Printing and distribution of Annual Report 1928	1,626 57	
Bulletins	1,449 33	
Quarterlies	1,876 20	4,952 10
,, Depreciation—		
Laboratory	48,933 95	
Experiment Station Buildings ..	9,179 00	58,112 95
,, Experiment Station—		
Recurrent expenditure		50,622 00
,, Balance Excess of Income over Expenditure carried down		167,218 77
		628,840 73
,, Balance carried to Balance Sheet ..		185,118 48
		185,118 48

INCOME—(*cont.*)	$ c.	$ c.
Brought forward ..		628,840 73
		628,840 73
By Balance being Excess of Income over Expenditure for year brought down		167,218 77
,, Contributions received in respect of previous periods—		
S.S. Government:		
Balance of 1928 contribution ..	17,402 45	
Trengganu Government:		
Balance of 4th Quarter 1928 ..	497 26	17,899 71
		185,118 48

(Sd.) V. LOUIS CACHEMAILLE,
Secretary.
16th January, 1930.

(Sd.) H. A. TEMPANY,
President.
25th January, 1930.